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Beta Factors for Collinear Asymmetrical Cracks Emanating from an Offset Circular Hole in a Rectangular Plate

Witold Waldman

Aerospace Division
Defence Science and Technology Group

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ABSTRACT

Beta factors, a nondimensional form of stress intensity factor, are a key input used in generating crack-growth curves as part of Damage Tolerance Analysis work. One specific damage scenario that is of interest is the case of collinear asymmetrical cracks emanating from an offset circular hole in a finite-width rectangular plate, which is representative of circumstances that can occur in aircraft fleets. Unfortunately, no handbook results are available for this geometry. Using a custom-written FORTRAN computer program, interfaced with an existing two-dimensional boundary element fracture analysis code, the present report provides an extensive set of Beta factor solutions covering a wide range of hole offsets and crack lengths. This work has also led to the derivation of an improved closed-form analytical two-dimensional Beta factor solution for the related case of symmetrical cracks emanating from a central hole in a finite-width strip. The availability of accurate Beta factors is an important element in the structural integrity management of aircraft in service with the Royal Australian Air Force. The database of results presented here supports research into probabilistic analysis of multi-site fatigue damage scenarios, as well as assisting the long-term ongoing structural integrity management of aircraft in service with the Royal Australian Air Force.

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Executive Summary

Aerospace Division has been deeply involved in the development and application of technologies that help to ensure the safety and enhance the availability of aircraft in service with the Royal Australian Air Force by extending the fatigue lives of airframe structural components. Many of these aircraft structures typically contain large numbers of circular holes that are fitted with fasteners. Fatigue damage often occurs at such holes during the service life of the aircraft, with attendant increases in operating costs and maintenance times. The determination of Beta factors, a nondimensional form of stress intensity factor, that are associated with cracks that occur at holes and other locations, is therefore of significant importance in fatigue life studies, many of which involve extensive and costly experimental fatigue testing.

The particular geometry of interest considered here consists of two asymmetrical collinear cracks emanating from an offset circular hole in a finite-width rectangular plate. These two through-thickness cracks are deemed to interact with each other. As there are no known prior solutions available for this particular scenario, even though there are many handbook solutions for other geometries, the aim of the present work is to determine the required Beta factor solutions in a form that will enable them to be readily utilised in fatigue life computations.

This report details the development and use of a FORTRAN 90 computer program that has been developed to determine Beta factors for two asymmetrical collinear cracks emanating from an offset circular hole in a finite-width rectangular plate. The software is comprised of a small library of subroutines that are used to compute Beta factors for the various cases of interest, which involve different combinations of plate size, hole diameter, hole offset and crack lengths. These subroutines interface with a two-dimensional boundary element program in order to perform the requisite fracture mechanics stress intensity factor calculations, which are then converted to Beta factors. The direct use of these subroutines saves considerable time and effort that is typically needed for developing interpolation routines to handle the tabulated Beta factor data, which are also supplied here in order to provide a comprehensive database of results. The extensive Beta solutions and software tools that have been developed and presented in this report are providing support for research into the probabilistic analysis of multi-site fatigue damage scenarios of aerospace significance. They will also assist in the long-term ongoing structural integrity management of aircraft in service with the Royal Australian Air Force. The computational approach developed and used in the present work is also very amenable to customisation to obtain Beta factors for other geometries. The present work has also led to the derivation of an improved closed-form analytical two-dimensional Beta factor solution that is applicable to symmetrical cracks emanating from a central hole in a finite-width strip.

Author

Witold Waldman
Aerospace Division

Mr Witold Waldman completed a BEng (with distinction) in Aeronautical Engineering at the Royal Melbourne Institute of Technology in 1981. He commenced work in Structures Division in 1982 at what was then the Aeronautical Research Laboratory. He has published a number of papers and reports, and his experience has focussed on stress analysis using finite element and boundary element methods, structural mechanics, fracture mechanics, computational unsteady aerodynamics, structural dynamics testing, digital filtering of flight test data, nonlinear optimisation, and spectral analysis. His recent work has been in the areas of structural shape optimisation and computation of stress intensity factors. He is currently a Senior Research Engineer in the Structural and Damage Mechanics Group in the Airframe Technology and Safety Branch of Aerospace Division within the Defence Science and Technology Group, Department of Defence.

Contents

Nomenclature

a	half-distance between crack tips
c	crack length as measured from adjacent hole edge
c_L	length of left crack as measured from adjacent hole edge
c_R	length of right crack as measured from adjacent hole edge
d	distance of centre of circular hole from left edge of plate
F	Beta factor
F_a	Beta factor (calculated using a)
F_{aL}	Beta factor for left crack (calculated using a)
F_{aR}	Beta factor for right crack (calculated using a)
F_c	Beta factor (calculated using c)
F_{cL}	Beta factor for left crack (calculated using c_L)
F_{cR}	Beta factor for right crack (calculated using c_R)
F_h	boundary correction factor accounting for effect of finite width of plate on the stress concentration at the hole
F_l	boundary correction factor accounting for uncracked ligament length
F_w	finite-width correction factor
F_∞	Beta factor for collinear symmetrical cracks emanating from a circular hole in an infinite plate
H	half-height of plate
K	stress intensity factor
K_L	stress intensity factor for left crack tip
K_R	stress intensity factor for right crack tip
K_T	stress concentration factor
l	uncracked ligament length
r	radius of hole in plate
S	nominal uniform tensile stress remote from the crack
W	half-width of plate
∞	infinity
λ	nondimensional crack length

1. Introduction

Multi-site fatigue damage is a potential issue in the risk management of many aircraft structures, such as the C-130J aircraft presently in service with the Royal Australian Air Force. It is known that crack growth rates are related to the stress intensity at crack tips, so the accurate computation of stress intensity factors as a function of crack length is an important consideration when conducting fatigue life analyses of cracked structures. In turn, stress intensity factors depend on the structural configuration and the load, including the shape, size and location of the crack. Stress intensity factors for cracks in an arbitrary geometry can be normalised by using a reference crack in a baseline infinite plate, producing a nondimensional form of stress intensity factor called a Beta factor.

A research activity has therefore been undertaken in the Structural and Damage Mechanics Group, Aerospace Division, to investigate the interactions that occur between multiple growing fatigue cracks. In this instance, the specific scenario of interest consists of asymmetrical collinear through-thickness cracks emanating from an offset circular hole in a uniaxially-loaded finite-width plate (see Figure 1). The Beta factors that have been computed here intrinsically include interaction effects between the left and right cracks, as well as proximity effects related to the distance of the hole and the cracks from the edges of the plate. These Beta factors can be used in probabilistic risk analyses of multi-site fatigue damage scenarios.

The general geometry of the plate, hole and cracks is given in Section 2. A variety of published graphical, tabulated and closed-form Beta factor solutions for geometries similar to the one presently under consideration are reviewed in Sections 3 and 4. These have been utilised to verify the operation of the boundary element fracture analysis code used in the present work. The computational approach to the present work is discussed in Section 5, and the verification of its expected computational accuracy is discussed in Section 6. In addition to the nominal required Beta factor solutions, an improved compact closed-form solution for computing stress intensity factors for equal-length cracks emanating from a centrally-located circular hole in a finite-width infinite strip is given in Section 7. A closed-form Beta factor solution for a circular hole with asymmetrical cracks in an infinite plate is discussed in Section 8. The tables of computed Beta factors for collinear asymmetrical through-thickness cracks emanating from an offset circular hole in a rectangular plate are presented in Section 9. A discussion of the work is given in Section 10, followed by the conclusion in Section 11.

2. Geometry of cracked plate

Referring to Figure 1, we have a rectangular plate of width $2W$ and height $2H$ that is subjected to a uniform uniaxial remote stress S on the two ends. The plate contains a circular hole of radius r whose centre is offset a distance d from the left edge of the plate. Two collinear through-thickness cracks of unequal length emanate from the hole, diametrically opposite to each other, and perpendicular to the direction of the applied stress S. The length of the left crack is c_L, while that of the right crack is c_R. The total distance between the crack tips is $2a$.

For the geometry depicted in Figure 1, the nondimensional Beta factors, F_{aL} and F_{aR}, for the left and right cracks can be defined using the following normalisation:

$$K_L = S\sqrt{\pi a}F_{aL} \tag{1}$$

$$K_R = S\sqrt{\pi a}F_{aR} \tag{2}$$

$$a = \frac{c_L + 2r + c_R}{2} \tag{3}$$

where K_L and K_R are the stress intensity factors for the left and right crack tips. Here we note that the factor $S\sqrt{\pi a}$ corresponds to the stress intensity factor for a through-crack of total length $2a$ in an infinite plate subjected to a remote uniaxial tension stress S.

Beta factors for the two crack tips are to be computed for a range of d/W and r/W values and for a range of combinations of crack lengths, c_L/r and c_R/r. The ten d/W values chosen to be used are: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0. The four r/W values to be used are: 0.05, 0.10, 0.15 and 0.20. The sixteen c_L/r and sixteen c_R/r values to be used are: 0.01, 0.02, 0.05, 0.075, 0.1, 0.15, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, and 2.0. A H/W ratio of 4 will be used to define a rectangular plate, one that can be considered to be nominally large relative to the largest hole size of r/W = 0.20. A separate pair of tables will be produced for each individual combination of d/W and r/W values, one table for each crack tip. These tables will provide Beta factor data that can subsequently be interpolated if and when required.

The above choice of c_L/r and c_R/r values will produce a set of Beta factors corresponding to both long and short crack lengths. However, some combinations of the nondimensional parameters d/W, r/W, c_L/r and c_R/r are not geometrically feasible, and these will not be computed.

Note that a value of d/W = 1.0 corresponds to the circular hole being in the centre of the plate. It is important to include this value as it represents a case for which some published Beta factor results exist in the scientific literature, therefore permitting comparison of the present results with those that have been obtained previously by other workers.

3. Published graphical and tabulated solutions

Well-known stress intensity factor handbooks, such as those by Murakami [1], Rooke and Cartwright [2], and Tada, Paris and Irwin [3], rely on the prior solutions computed by Newman [4], Kitagawa and Yuuki [5], Rooke and Tweed [6], Isida and Nakamura [7], Murakami [8], and Nisitani and Isida [9]. However, they do not offer solutions for Beta factors for the case that is of present interest (see Figure 1), which concerns collinear asymmetrical cracks emanating from an offset hole in a uniaxially-loaded finite plate.

Newman [4] applied a complex variable method in conjunction with a modified boundary-collocation method to the two-dimensional stress analysis of two equal-length collinear cracks emanating from a central circular hole in both finite and infinite plates remotely loaded by a uniform uniaxial stress. Tabulated results were provided for cracks emanating from holes corresponding to two different ratios of hole radius to plate width, r/W = 0.25 and r/W = 0.50. The results provided therein are expected to be accurate to within 0.1% [4]. This particular plate geometry was also analysed using a conformal mapping method by Kitagawa and Yuuki [5], who studied cases corresponding to r/W = 0.10 and r/W = 0.25. Their results are expected to be accurate to within 1% [1], and are in excellent agreement with those of Newman [4].

Rooke and Tweed [6] used an integral transform method to accurately solve the elastic problem of two unequal-length collinear cracks emanating from the edge of a hole of radius r in an infinite plate remotely loaded by a uniform uniaxial stress. Their tabulated results covered crack lengths in the range $0 \le c/r \le 10$, and were quoted to be accurate to within 0.1%. Using a body force method, Isida and Nakamura [7] have provided tabulated results for unequal crack lengths over a more limited range $0 \le c/r \le 1$ (republished by Murakami [1]).

Rooke and Tweed [6] also provided a solution for the special case of equal-length cracks for crack lengths in the range $0 \le c/r \le 10$. Their solution has been found to be in excellent agreement with the results obtained by Murakami [8] and Nisitani and Isida [9] using the body force method (republished by Murakami [1]), and also those of Newman [4].

More recently, Harter and Taluk [10] used the commercial *p*-element StressCheck finite element analysis program to compute stress intensity factors for unequal cracks growing from an offset circular hole in a finite plate remotely loaded by a uniform tension stress. They analysed over 400 separate cases covering a wide range of hole and crack geometries in a rectangular plate with $H/W = 4$. Tabulated results were provided for different combinations of hole size covering the range $0.00625 \le r/W < 0.5$, hole offset covering the range $0.25 \le d/W \le 1$, and crack length parameters covering the range $0.04 \le c_L/r \le 144.0$ and $0.4 \le c_R/r \le 214.4$. Of course, not all combinations of parameters in the ranges shown are geometrically feasible.

4. Published closed-form solutions

For the stress intensity factor corresponding to two equal-length collinear through-thickness cracks emanating from a central circular hole in an infinite plate remotely loaded by a uniform uniaxial stress, Murakami [1, 8], Tada, Paris and Irwin [3], Schijve [11], and Newman [12], have all presented closed-form expressions. The equation developed by Schijve [11] appears to have the best accuracy and is valid for all crack lengths.

A review of publications was conducted to identify available solutions that are related to the problem of asymmetric cracks emanating from a circular hole. A general closed-form solution for an elliptical hole in an infinite plate has previously been presented by Murakami [1, 8], for which a circular hole is a limiting case (see the geometry presented in Figure 2). For the case of a circular hole, the stress intensity factor for the left crack, K_L, can be computed using the equations provided below.

$$\begin{aligned} K_L &= S\sqrt{\pi c_L}\,F(\lambda)\sqrt{\frac{r+(c_L+c_R)/2}{r+c_L}} \\ &= S\sqrt{\pi a}\,F(\lambda)\sqrt{\frac{c_L}{r+c_L}} \end{aligned} \tag{4}$$

$$F(\lambda) = 3.3645\left(1+0.2238\lambda-0.1643\lambda^2\right)\left[\frac{1}{3}+\frac{1}{6}\left(\frac{1}{(1+\lambda)^2}+\frac{3}{(1+\lambda)^4}\right)\right] \tag{5}$$

$$\lambda = \frac{c_L}{r}$$

Murakami [1] states that the above closed-form solution is accurate to within 10% (less than 5% for most cases) for crack lengths in its range of applicability, which is quoted as being $0 \leq c_L/r \leq 1$. The results obtained when using this solution are in good agreement with those published by Isida and Nakamura [7]. Note that these equations can be used to compute the stress intensity factor for the right-hand crack, K_R, by simply switching the crack dimensions c_R and c_L.

The term $F(\lambda)$ proposed by Murakami [1] is equivalent to the Beta factor for symmetric ($c_L = c_R = c$) through cracks emanating from a circular hole in an infinite plate, whereupon the stress intensity factor can be computed as $K = S\sqrt{\pi c}F(\lambda)$, with $\lambda = c/r$. From this it is apparent that the additional square root term in the expression for K is the correction that is used to account for crack asymmetry (unequal crack lengths). Note, however, that the approximating function $F(\lambda)$ does not display the correct asymptotic behaviour as $\lambda \rightarrow \infty$, approaching $-\infty$ instead of 1. In fact, the function $F(\lambda)$ can only be relied upon to be reasonably accurate in the range $0 \leq \lambda \leq 1$, which is usually the range of most interest. If crack lengths $\lambda > 1$ are of interest, then this feature of the approximating function could be seen to be somewhat of a limitation.

For the case of very short cracks compared to the notch radius, say $c \leq r/10$, a limiting solution is available. As described by Yu *et al*. [13], the problem can be treated approximately as an edge through crack in a semi-infinite plate subjected to the local peak stress, which is dependent on the local stress concentration factor, K_T. The stress intensity factor is given by:

$$\begin{aligned} K &= S\sqrt{\pi c}F \\ F &= 1.1215 K_T \end{aligned} \tag{6}$$

For a circular hole in an infinite plate, $K_T = 3$, so the stress intensity factor K becomes:

$$K = 3.3645 S\sqrt{\pi c} \tag{7}$$

For a central circular hole in a finite-width infinite strip under tension, the following expression for K_T in terms of the plate half-width W and hole radius r, found in *Peterson's Stress Concentration Factors* [14, Chart 4.1], can be used:

$$K_T = 0.284 + 2\left(1-\frac{r}{W}\right)^{-1} - 0.600\left(1-\frac{r}{W}\right) + 1.32\left(1-\frac{r}{W}\right)^2 \tag{8}$$

Using the above formula, when $r/W = 0.5$ then $K_T = 4.314$, which is 44% higher than for a hole in an infinite plate, indicating that finite-width effects will have a significant influence on the stress intensity factor.

Schijve [11] has obtained the following Beta factor equation for two collinear symmetrical cracks emanating from a circular hole in an infinite plate, F_∞, by data fitting the results presented by Newman [4].

$$K = S\sqrt{\pi c}F_\infty$$

$$F_\infty = 1 + \frac{1}{2\left(\frac{c}{r}\right)^2 + 1.93\left(\frac{c}{r}\right) + 0.539} + \frac{1}{2\left(\frac{c}{r}+1\right)} \tag{9}$$

In contrast to the more restricted range of validity of $F(\lambda)$ in Equation (5), the function F_∞ of Equation (9) is valid over the range $0 \le c/r \le \infty$, and has the correct asymptotic behaviour for large values of c/r ($F_\infty \to 1$ as $c/r \to \infty$). It fits the results of Newman [4] to better than 0.41% accuracy in the range $0.01 \le c/r \le 3$ (corresponding to the range of the available comparison data). It is a better fit to that data than the Bowie correction factor that was used by Newman [12] in earlier work.

Newman [12] has proposed two approximate geometric correction factors, F_h and F_w, which can be used to adjust stress intensity factors that are computed using Equation (9). Application of these two factors results in the following equations for the stress intensity factor and related Beta factor F_c:

$$K = S\sqrt{\pi c}\,F_c \tag{10}$$

$$F_c = F_\infty\, F_h\, F_w \tag{11}$$

$$F_h = \sqrt{\sec\left(\frac{\pi}{2}\frac{r}{W}\right)} \tag{12}$$

$$F_w = \sqrt{\sec\left(\frac{\pi}{2}\frac{r}{W}\left(1+\frac{c}{r}\right)\right)} \tag{13}$$

The boundary correction factor F_h accounts for the effect of the finite width of the plate on the stress concentration at the hole. The correction factor F_w accounts for the influence of the finite width of the plate on the cracks. For any given plate and hole geometry, F_h is a constant, while F_w increases with increasing crack length. As the ratio $r/W \to 0$, which in the limit corresponds to the infinite-plate case, we have that $F_h \to 1$ and $F_w \to 1$. F_w corresponds to the well-known secant expression originally proposed by Feddersen [15], which itself provides a very good approximation to the 18th-degree polynomial geometry factor for a centre-cracked semi-infinite panel that was determined by Isida [16]. The secant expression is accurate up until about $r/W = 0.90$, where it produces a result that is only 2.3% higher, while by $r/W = 0.95$ it is 15.6% higher.

5. Computational approach for present work

Chang and Mear [17] have developed a modification to the boundary element method for the analysis of cracks in two-dimensional solids. A key advantage of the boundary element approach is that only the boundary of the body requires discretisation, which significantly simplifies the modelling procedure. The computational scheme that they developed for two-dimensional linear elastic fracture analysis is both accurate and efficient, and it is applicable to a wide class of two-dimensional fracture problems. These include both embedded and

surface breaking linear and curvilinear cracks, multiple interacting cracks, and crack growth. In their implementation, the cracks are modelled via integral equations involving a distribution of dislocations and a distribution of concentrated forces. The method is applicable to both infinite and finite domains, and the use of the former offers the useful capability to compare results with those obtained from theoretical solutions. Their work was performed with support from the NASA Airframe Structural Integrity Program (Contract NAG-1-1121) under the direction of Dr CE Harris and Dr JC Newman Jr.

A Windows XP-compatible program, called FADD2D, implementing the method of Chang and Mear, has been developed by Newman *et al*. [18]. A copy of this program was obtained after private communication with Dr James C Newman Jr, Mississippi State University, Department of Aerospace Engineering. FADD2D provides a graphical user interface that facilitates model creation, meshing, solution computation and examination of results. After the user-defined geometry has been created, a text file called *fadd.in* is written out, which contains the definition of the problem to be solved. FADD2D then executes *MFADD.EXE*, which is the computational engine that reads in the input data contained in *fadd.in* and performs the calculations. Amongst other output files created by *MFADD.EXE*, the file *sifs.ot* contains the stress intensity factors corresponding to the crack tips that were defined in the model.

The FADD2D program was installed and used to create a model corresponding to the geometry presented in Figure 1. Values of H = 80 mm, W = 20 mm, r = 10 mm, d = 20 mm, and $c_L = c_R$ = 1.0 mm were used. Figure 3(a) shows the complete boundary element model of the hole in a rectangular plate with two cracks emanating from the left-hand and right-hand edges of the hole. The cracks depicted here have lengths $c_L = c_R$ = 5.0 mm to make them visible in the diagram. The external boundary of the plate is comprised of 10 straight-line segments numbered 1 through 10. The internal boundary of the plate, which represents the circular hole, is comprised of 10 circular arc segments. A zoomed-in view of the mesh in the vicinity of the left-hand crack is shown in Figure 3(b). Shorter external boundary segments are used in the region where the crack tips will approach the plate edges as the cracks extend, as well as on the internal boundary (hole edge) at the crack initiation locations. Each of the boundary segments on either side of the two crack initiation locations utilised 8 nodes to provide a moderate degree of mesh refinement. The graded mesh option was used when defining the cracks, which refines the mesh near the crack tips, with each crack having 12 nodes along its length.

The resulting *fadd.in* input data file is listed in Appendix A, and it consists of the definition of the internal hole boundary, the outer boundary of the plate, and the two cracks either side of the hole. Based on the prior knowledge of the geometry, it is relatively straightforward to identify the various sections in the input data that correspond to each component of the geometry. By manipulating the text data contained in *fadd.in*, it is possible to straightforwardly create new data files that enable variations of the given geometry to be analysed.

In the present work, a general purpose FORTRAN 90 subroutine has been developed, called UCOCHFPUT, which allows the user to input the desired values of H/W, d/W, r/W, c_L/r and c_R/r. It writes out a new version of *fadd.in* based on the user-supplied values of those parameters, using an embedded version of the *fadd.in* file as a template (listed in Appendix A). It then executes *MFADD.EXE* and extracts the computed stress intensity factors for the two crack tips. These are then normalised in two different ways, one using $a = (c_L+2r+c_R)/2$ as the equivalent crack length, and the other using the individual crack lengths associated

with each separate crack, c_L and c_R. Therefore, two pairs of nondimensional Beta factor values are computed and returned to the calling program. For the preconfigured number of elements, each such computation takes approximately 1.5 seconds of execution time on a PC using an Intel Core2 Duo E6550 2.33 GHz CPU, with the majority of the time taken up by the execution of *MFADD.EXE*.

Various additional FORTRAN 90 subroutines have also been developed to handle the cases of collinear asymmetrical and equal-length through cracks emanating from a circular hole in finite and infinite plates remotely loaded by a uniform uniaxial tension stress. The first of these subroutines is called UCCHIPUT, and it is once again based on the use of the *MFADD.EXE* program. It allows the user to input values of c_L/r and c_R/r, and, as was the case for subroutine UCOCHFPUT, two pairs of nondimensional Beta factor values are produced and returned to the calling program. The *fadd.in* template file that was created and used for this purpose is listed in Appendix B, and the corresponding FADD2D boundary element mesh is shown in Figure 4. For cracks of unequal lengths in an infinite plate, subroutine BetaUCHIPM implements Equation (4), which corresponds to the closed-form equation developed by Murakami [8]. For cracks of equal lengths in an infinite plate, subroutine BetaECHIPM implements Equation (5), which is the closed-form equation published in Murakami [8], while subroutine BetaECHIPS implements Equation (9), which is the closed-form equation developed by Schijve [11].

6. Verification of computational accuracy

A FORTRAN 90 computer program, called RunMFADD, has been written in order to demonstrate the use of the various subroutines. The source code to the RunMFADD program is provided in Appendix C, and it includes all of the subroutines that were mentioned in the previous section. A screen snapshot of the menu choices that are displayed when the RunMFADD program is executed is presented in Appendix D, together with a table listing the names of the output files associated with each menu choice. In order to check that the subroutines developed here are operating correctly, a number of published results [1–10] have been used as test cases to confirm that the boundary element formulation of Chang and Mear [17] that is being utilised here is producing reliable results for a wide range of crack lengths, hole sizes, and hole offsets.

6.1 Two equal cracks from a circular hole in an infinite plate

Figure 5 shows the Beta factor F_a for two equal collinear through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress. Here the results obtained using subroutine UCCHIPUT (referred to as FADD in the legend, and denoted by the solid line) are compared to those obtained using Schijve's closed-form equation [11], as well as the tabulated results published by Rooke and Tweed [6] and Nisitani and Isida [1, 9]. The results presented in Figure 5 cover the range $0.001 \le c/r \le 10$. It is evident that the results obtained using FADD2D are in excellent agreement with those obtained by other workers, and that the correct asymptotic behaviour is displayed as $c/r \to \infty$.

6.2 Two equal cracks from a central circular hole in a finite plate

Figure 6 shows a collection of Beta factors F_a, where $K = S\sqrt{\pi a}\, F_a$, for two equal collinear through cracks emanating from a central circular hole in a finite plate subjected to a uniform

uniaxial remote tension stress. The plate has a height-to-width aspect ratio of $H/W = 2$. The results are presented for four different hole radius to plate width ratios of $r/W = 0$, 0.10, 0.25 and 0.50. The various solid, dashed and dotted lines correspond to the results obtained using FADD2D, and these are in excellent agreement with those obtained by Newman [4] for $r/W = 0$, 0.25 and 0.50, as well as those for $r/W = 0.10$ given by Kitagawa and Yuuki [5] (also in Murakami [1]).

6.3 Two unequal cracks from a circular hole in an infinite plate

Figure 7 shows a collection of Beta factors F_{aR}, where $K_R = S\sqrt{\pi a}\,F_{aR}$, for the right-hand crack of two collinear through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress. The cases studied here include equal as well as asymmetrical crack lengths. It is evident that the results obtained using FADD2D are in excellent agreement with those published by Rooke and Tweed [6].

Figure 8 shows a collection of Beta factors F_{cR}, where $K_R = S\sqrt{\pi c_R}\,F_{cR}$, for the right-hand crack of two collinear unequal through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress. It is evident that the results obtained using FADD2D are in excellent agreement with those published by Isida and Nakamura [7] and Rooke and Tweed [6]. For the instances when $c_R/r = 0$ and/or $c_L/r = 0$, very small but finite crack lengths of $c_R/r = 0.0001$ and/or $c_L/r = 0.0001$ were used for the FADD2D computations. For the case where $c_R/r = c_L/r = 0$, FADD2D computed $F_{cR} = 3.344$. This is in excellent agreement with the value obtained by Rooke and Tweed of $F_{cR} = 3.364$, which is only 0.6% higher. These values compare very favourably to the theoretically obtained value of $F = 3.3645$ (see Equation (7)), corresponding to an edge through crack in a semi-infinite plate subjected to a local peak stress matching that of a circular hole in an infinite plate subjected to a uniform remote tension stress. It is also evident that the limiting results for F_{cR} computed using FADD2D for the case of $c_L/r = 0$ and $0.1 \le c_R/r \le 1$ are also in excellent agreement with those published by Isida and Nakamura [7]. For any given c_R/r ratio, it is evident that the Beta factor for the right-hand crack increases slowly as the left-hand crack gets progressively longer. Apart from a short transition region, nominally covering the range $0 \le c_L/r \le 0.2$, the rate of increase of F_{cR} with c_L/r appears to be quite linear.

Figure 9 shows a collection of Beta factors F_{cR}, where $K_R = S\sqrt{\pi c_R}\,F_{cR}$, for the right-hand crack of two collinear unequal through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress. For this wide range of crack lengths, it is evident that the results obtained using FADD2D are in excellent agreement with those published by Rooke and Tweed [6]. Note that for the case when $c_L/r = 0$, a very small but finite crack length of $c_L/r = 0.0001$ was used for the FADD2D computations.

6.4 Two unequal cracks from an offset circular hole in a finite plate

The FADD2D method was also used to compute stress intensity factors using the hole radius, hole offset and crack length geometries that were published by Harter and Taluk [10] (see their Cases 1 to 9 in Table E1.1, and Case 10 in Table E2.1). Harter and Taluk utilised the StressCheck *p*-element finite element analysis code to perform their analyses using an H/W ratio of 4, and this ratio was utilised in the FADD2D computations. All of the present FADD2D-computed results were compared to those of Harter and Taluk for both the left-hand and right-hand cracks. In order to provide an overall view of the comparison of the

results of all the cases, a scatter plot of the ratio of the FADD2D results to those obtained by Harter and Taluk is shown in Figure 10. The mean ratio was 0.994 with a standard deviation of 0.014. A histogram analysis determined that 78.2% of the FADD2D results were within ±1.5% of Harter and Taluk's results, while 89.2% were within ±2.5%. When larger differences were apparent, the FADD2D method generally estimated smaller stress intensity values. Overall, the results indicate that the FADD2D method was generally in very good agreement with the results of Harter and Taluk's StressCheck analyses. Being a finite element code, the results obtained using StressCheck are possibly susceptible to the choice of mesh discretisation.

Considering the generally very good agreement displayed between the present FADD2D-computed results and those obtained by other methods of analysis, a further investigation was undertaken to try and understand the reasons why some of the FADD2D-computed results differed more than expected from those of Harter and Taluk [10]. A closer examination of Harter and Taluk's results indicates that some of the differences between their analyses and the present results occur under circumstances when one or both crack tips get close to the edges of the plate. This can be seen in Figure 11, which plots the ratios of the two sets of results that were obtained for the left-hand and right-hand cracks against the ratio of the relevant crack length to the uncracked ligament length, $c_L/(d-r)$ for the left-hand crack and $c_R/(2W-d-r)$ for the right-hand crack.

For example, consider one case that was studied, where $r/W = 0.0625$, $d/W = 1.0$ and $c_R/r = c_L/r = 14.40$, which corresponds to $a/W = 0.96$. This particular case consists of a very small hole in a plate from which two very long symmetrical cracks emanate. Harter and Taluk [10] computed a Beta factor of $F_a = 4.2474$ for this case (where $K = S\sqrt{\pi a}\, F_a$). The present method computed $F_a = 4.1175$, which is 3.1% less.

This particular case is very similar to that of a centre-crack in a finite-width strip, a geometry for which Tada [19] has proposed a modification to the Feddersen formula, resulting in the following equation to determine the Beta factor F_a:

$$F_a = \left\{1 - 0.025\left(\frac{a}{W}\right)^2 + 0.06\left(\frac{a}{W}\right)^4\right\}\sqrt{\sec\left(\frac{\pi}{2}\frac{a}{W}\right)} \tag{14}$$

Newman and Haines [20] have verified that Tada's equation is accurate to within 0.2% of their numerical results for crack length to plate width ratios in the range $0 < a/W < 0.95$.

For our particular geometry of interest, when $a/W = 0.96$, the above equation gives $F_a = 4.1022$. This is within 0.4% of the FADD2D-computed result for this geometry (including the hole, which we recall is very small relative to the width of the plate). Hence, this result provides us with some degree of confidence that the present FADD2D-computed results can be regarded as being more accurate than those computed by Harter and Taluk.

7. Improved closed-form solution for a central hole in a finite strip with symmetrical cracks

As a new development and an outcome of the present work, we propose here an additional boundary correction factor, F_l, which is applicable to the case of symmetrical cracks emanating from a central hole in a finite-width strip. This factor is a new term that accounts

for the effect of the uncracked ligament length, $l = W–r$, in combination with the size of the hole relative to the plate width. The new equation for the stress intensity factor is defined below, where F_∞, F_h and F_w were defined earlier.

$$K = S\sqrt{\pi c}\, F_c \tag{15}$$

$$F_c = F_\infty\, F_h\, F_w\, F_l \tag{16}$$

$$F_l = \sqrt{\cos\left(\frac{\pi}{2}\frac{r}{W}\left(\frac{c}{W-r}\right)\right)} \tag{17}$$

For any given combination of plate width and hole size, the effect of F_l decreases with increasing crack length. For combinations of values of r/W and $c/(W–r)$ where $0 \le r/W \le 0.70$ and $c/(W–r) \le 0.10$, it is noted here that $F_l \ge 0.9970$, and therefore it has a negligibly small effect. In comparison, when $r/W = 0.70$ and $c/(W–r) = 0.50$, $F_l = 0.9234$ and the correction factor therefore has a significant effect on the computed value of the Beta factor.

Figure 12 shows the Beta factors F_c, where $K = S\sqrt{\pi c}\, F_c$, as a function of crack length normalised by the uncracked ligament length, $c/(W–r)$, that were obtained by using Equation (16) for three different r/W ratios of 0.10, 0.25 and 0.50. For each r/W ratio, the Beta factor decreases as the cracks extend out from the hole, until a minimum is reached, whereupon the Beta factor begins to increase as the cracks get closer to the edges of the plate. The results are compared to the accurate solutions obtained by Newman [4] and Kitagawa and Yuuki [5] for a finite-width plate with $H/W = 2$. Compared to Newman's results, particularly for $r/W = 0.25$ and $r/W = 0.5$, it is evident that Equation (16) underestimates the Beta factor somewhat as the crack tips approach the sides of the plate. This is because Equation (16) is based on the solution for a semi-infinite plate, and this approximation becomes less accurate as the size of the hole increases relative to the height of the finite plate that was analysed by Newman as well as Kitagawa and Yuuki. Based on the available data used for this particular comparison, Equation (16) is considered to provide reasonably accurate Beta factor values for parameter ranges $0 \le r/W \le 0.5$ and $0 \le c/(W–r) \le 0.8$. In particular, it should be noted that the accuracy of the function is better than 1% for $0 \le r/W \le 0.25$ and $c/(W–r) \le 0.8$.

Figure 13 shows the Beta factors F_c, where $K = S\sqrt{\pi c}\, F_c$, that were computed using FADD2D as a function of crack length normalised by the uncracked ligament length, $c/(W–r)$, for a finite-width plate with $H/W = 8$ and five different r/W ratios of 0.10, 0.25, 0.50, 0.60 and 0.70. For this increased value of H/W, it is expected that this finite-width plate will more closely approximate the behaviour of a semi-infinite strip. The results are compared to those obtained using Equation (16).

Although it is evident in Figure 13 that Equation (16) becomes somewhat less accurate for larger values of r/W when $0.1 \le c/(W–r) \le 0.95$, the predictions are still within just a few percent of the FADD2D-calculated values. In the central region of that $c/(W–r)$ range, there is a point where the function predictions cross over from slightly over estimating to slightly under estimating the Beta factor. For values of $c/(W–r)$ lying towards the $c/(W–r) = 0.1$ end of this particular range, the function predictions are usually slightly greater than the FADD2D-computed values. On the other hand, for values of $c/(W–r)$ lying towards the $c/(W–r) = 0.95$ end of the given range, the function predictions are usually a littler lower than

the FADD2D-computed values. For example, the Beta factor predicted by Equation (16) when $c/(W\text{–}r)$ = 0.8 and r/W = 0.7 is F_c = 7.991, which is only 3.9% less than the value computed using FADD2D. For this particular case, the correction factor produced by Equation (17) is F_l = 0.7984. Looking at another point, this time when $c/(W\text{–}r)$ = 0.2 and r/W = 0.7, the predicted Beta factor is F_c = 6.890, which is only 3.4% higher than the value computed using FADD2D. For the more extreme case of $c/(W\text{–}r)$ = 0.95 and r/W = 0.7, Equation (16) gives F_c = 13.425. This is only 2.1% greater than the value computed using FADD2D. For this particular case, the correction factor produced by Equation (17) is F_l = 0.7087. For shorter crack lengths, e.g. $c/(W\text{–}r) \le 0.1$, where the influence of the finite plate width on the cracks is not as strong, it appears that Equation (16) is capable of providing very accurate results that are typically within 2% of those computed by FADD2D.

8. Closed-form solution for a circular hole with asymmetrical cracks in an infinite plate

Utilising an amalgamation of the prior work of Murakami [8] and Schijve [11], both of whose results were discussed in Section 4, it is possible to define a pair of closed-form expressions for the stress intensity factors associated with the asymmetric collinear cracks emanating from a circular hole in an infinite plate that is uniformly loaded by a remotely applied tension stress. The stress intensity factors for the left-hand and right-hand crack tips, K_L and K_R, can be calculated using the following equations:

$$K_L = S\sqrt{\pi c_L}\,F_{cL} \tag{18}$$

$$F_{cL} = F_\infty\left(\frac{c_L}{r}\right)\sqrt{\frac{r+(c_L+c_R)/2}{r+c_L}} \tag{19}$$

$$K_R = S\sqrt{\pi c_R}\,F_{cR} \tag{20}$$

$$F_{cR} = F_\infty\left(\frac{c_R}{r}\right)\sqrt{\frac{r+(c_L+c_R)/2}{r+c_R}} \tag{21}$$

In Equation (19) and Equation (20), the expressions involving the $\sqrt{\ }$ are the same as those given by Murakami [8], while F_∞ corresponds to the expression given by Schijve [11].

Equation (19) was used to compute Beta factors F_{cL} for the left-hand crack for seven different c_L/r ratios (0.01, 0.1, 0.2, 0.5, 1.0, 4.0 and 10.0) and a number of c_R/r ratios in the range $0.01 \le c_R/r \le 10$. The results are presented in Figure 14 where they are compared to the solutions that were computed using FADD2D. The area that falls below the solid red line corresponds to the region where Equation (19) computes Beta factor values that are within 5% of those obtained by FADD2D. In the range $0.01 \le c_R/r \le 1$, the agreement is considered to be very good for $0.1 \le c_L/r \le 10$. In particular, the results are seen to be in excellent agreement for relative crack length ratios of around $c_R/c_L = 1$. However, it is evident that the accuracy for F_{cL} deteriorates quickly for $c_R/r > 1$ as $c_L/r \rightarrow 0.01$, and this is particularly noticeable when $c_L/r < 0.5$. It is apparent that Equation (19) overestimates F_{cL} more and more as c_R/c_L increases above 1, while F_{cL} is underestimated when $c_R/c_L < 1$, albeit only slightly by no more than about 3%.

In a similar manner, Equation (21) was used to compute the Beta factors F_{cR} for the right-hand crack. The results are presented in Figure 15 and are compared to the solutions that were computed using FADD2D. The area that falls below the solid red line corresponds to the region where Equation (21) computes Beta factor values that are within 5% of those obtained by FADD2D. The agreement can be regarded as being quite good within the parameter ranges $0.01 \le c_R/r \le 10$ and $0.01 \le c_L/r \le 1$. However, it is evident that the predicted values of F_{cR} get progressively less accurate as c_R/r gets smaller and smaller, and the inaccuracy becomes quite noticeable for values of $c_L/r \ge 1$. For example, when $c_R/r = 0.01$ and $c_L/r = 10$, the discrepancy between the two sets of results is about 20%, whilst when $c_L/r = 0.50$ the discrepancy has reduced considerably and is only about 5%.

Subroutine BetaUCHFWIS implements Equations (19) and (21), and the FORTRAN 90 source code is included in Appendix C. However, as implemented there, the subroutine was designed to study potential equations that could be used to compute solutions involving a finite-width infinite strip, and hence modified trial forms of Equations (19) and (21) were defined. In order to compute the solutions for a circular hole in an infinite plate, this subroutine requires that a value of $r/W = 0$ be used (and this was the case when computing the solutions presented in Figure 14 and Figure 15).

9. Computed Beta factors for collinear asymmetrical cracks from an offset circular hole in a rectangular plate

The results from the test cases described in the previous sections provide a good measure of confidence that the estimates of stress intensity factor produced by FADD2D are accurate and reliable for a wide range of geometric parameters associated with problems that are similar or identical to the one that is presently under consideration. A FORTRAN 90 subroutine called CreateTables was therefore written to perform the computations required to generate the set of tabulated Beta factor results specified in a previous section. This subroutine is incorporated into the RunMFADD program (see the listing in Appendix C), and it is accessed by selecting option 8 from the RunMFADD menu (see the menu structure documented in Appendix D).

While the calculations are proceeding, the RunMFADD program writes each solution point to the screen, as well as to the output file called *PlateTables.out*. Once the solution space is fully populated with results, the requested tables are appended to the output file. Appendix E shows an example table taken from the completed output file, which corresponds to the case with $H/W = 4$, $d/W = 0.1$ and $r/W = 0.05$. The table is presented in two parts, with the one labelled Fa_L corresponding to the Beta factors for the left crack, while the one that is labelled Fa_R corresponds to the Beta factors for the right crack, with the corresponding stress intensity factors defined as $K_L = S\sqrt{\pi a}F_{a\_L}$ and $K_R = S\sqrt{\pi a}F_{a\_R}$. Whenever "NA" occurs in the table, this denotes that the Beta factors were not computed because the combination of input parameters corresponded to an invalid geometry (one that was not physically realisable).

Note that the output file *PlateTables.out* contains some header information preceding the tables. There are lines of data in this header that define the number of values in the sets comprising the parameters d/W, r/W, c_L/r and c_R/r. These are denoted by "N:d/w", "N:r/w", "N:c_L/r" and "N:c_R/r", respectively. Each of those lines is followed by a list consisting of the set of values defined for the parameter in question, denoted by "d/w[]", "r/w[]", "c_L/r[]", and "c_R/r[]". The notation "[]" is used here to indicate that each

provided sequence of values forms a one-dimensional array. If required, the formatting of the tabulated data should make it relatively straightforward to import the tables into a spreadsheet, such as Microsoft Excel, when using spaces as the data delimiter.

Table 1 to Table 36 present the Beta factors F_{aL} and F_{aR} that were computed and stored in the output file *PlateTables.out*, where $K_L = S\sqrt{\pi a}\,F_{aL}$ and $K_R = S\sqrt{\pi a}\,F_{aR}$, for the left-hand and right-hand collinear cracks emanating from a circular hole in a rectangular plate subjected to a remote uniform tension stress. The Beta factors F_{aL} and F_{aR} correspond to Fa_L and Fa_R in the output file. The normalisation used for these Beta factors is based on the geometry presented in Figure 1 and the stress intensity factor formulas given in Equations (1) to (3). If results are unavailable due to the geometry being invalid for any given set of parameters, this is denoted by using a "–" in these tables, which is equivalent to the use of "NA" in the output file *PlateTables.out*. In some cases, while processing the defined parameter space, some tables were completely empty of results, and these have been omitted.

As an example of the results that are available in the Tables, Figure 16 shows the Beta factors F_{aL} for the left-hand crack of two collinear unequal through cracks emanating from an offset circular hole with parameters r/W = 0.2 and d/W = 0.5, in a finite plate of H/W = 4, subjected to a uniform uniaxial remote tension stress. The Beta factors are plotted as a function of the left-hand crack length c_L/r for various fixed values of the right-hand crack length c_R/r.

In another example, Figure 17 shows the Beta factors F_{aR} for the right-hand crack of two collinear unequal through cracks emanating from an offset circular hole with parameters r/W = 0.2 and d/W = 0.5, in a finite plate of H/W = 4, subjected to a uniform uniaxial remote tension stress. The Beta factors are plotted as a function of the left-hand crack length c_L/r for various fixed values of the right-hand crack length c_R/r.

In a further example, Figure 18 shows the Beta factors F_{aL} for the left-hand crack of two collinear unequal through cracks emanating from an offset circular hole with parameter d/W = 0.5, in a finite plate of H/W = 4, subjected to a uniform uniaxial remote tension stress. The Beta factors are plotted as a function of the left-hand crack length c_L/r for various values r/W corresponding to the case where $c_R/r = 1$.

10. Discussion

The present work has resulted in a number of additional outcomes over and above the original requirement for producing a set of tabulated Beta factors. These are:

1. In a new development, a finite-width correction factor has been proposed that permits the use of a compact closed-form solution for computing stress intensity factors for equal-length through cracks emanating from a centrally-located circular hole in a two-dimensional finite-width infinite strip subjected to a remote uniform tension stress. The accuracy of the proposed equation has been tested against numerical results obtained using the FADD2D program, and has been found to be within 1% for $0 \le r/W \le 0.25$ and $c/(W{-}r) \le 0.8$, while providing reasonably accurate results in the range $0.25 < r/W \le 0.5$ and $0.8 < c/(W{-}r) \le 0.9$.

2. A FORTRAN 90 subroutine, UCOCHFPUT, has been written to compute Beta factor solutions for a pair of collinear asymmetrical through cracks emanating from an offset circular hole in a finite rectangular plate subjected to a remote uniform tension

stress. This subroutine interfaces with the general boundary element computational capabilities of the FADD2D program. Solutions can be computed as a function of the parameters H/W, r/W, d/W, c_L/r and c_R/r. For plate geometries of $r/W \le 0.5$ and $H/W \ge 2$, the solutions are close to those for an infinite finite-width strip. Although quite short crack lengths can be used, crack length to hole radius ratios, c/r, should be greater than 0.001 to avoid numerical difficulties. UCOCHFPUT is expected to provide accurate results for crack length to uncracked ligament length ratios, $c_L/(d-r)$ and $c_R/(2W-d-r)$, in the range 0.01 to 0.98.

3. An ancillary subroutine, called UCCHIPUT, has also been created for computing Beta factor solutions for asymmetrical through cracks emanating from a circular hole in an infinite plate subjected to a remote uniform tension stress.

The subroutines UCOCHFPUT and UCCHIPUT permit an analyst to directly compute accurate Beta factors for problems involving asymmetrical through cracks growing from either an offset circular hole in a finite-width plate or a circular hole in an infinite plate, whenever they are needed in fracture analysis and fatigue life analysis programs. It is anticipated that considerable time can be saved through the use of these subroutines, as there is no longer a pressing need to develop complex interpolation procedures to handle data sets provided in tabular or other formats. However, being based on a full boundary element solution, there is some degree of computational overhead associated with the use of the subroutine, which may need to be considered for applications where computational time could become an issue of concern.

11. Conclusion

A set of tables of Beta factors for a pair of collinear asymmetrical cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress has been computed and is provided here. The results presented in the Beta factor tables were computed using a program that implements a modified boundary element approach that is based on the method of distributed dislocations. This program has been extensively benchmarked here against known Beta factor solutions that are available in the scientific literature, and it has been found to have a high computational accuracy.

A wide range of crack lengths, hole diameters and hole offsets has been analysed, through the use of the following nondimensional parameters: d/W, r/W, H/W, c_L/r and c_R/r. This extensive database of Beta factors will serve to support research into probabilistic analysis of multi-site fatigue damage scenarios, as well as assisting in the long-term ongoing structural integrity management of aircraft in service with the Royal Australian Air Force. An improved closed-form two-dimensional Beta factor solution applicable to symmetrical cracks emanating from a central hole in a finite-width strip has also been determined.

Although a quite specific fracture mechanics problem has been considered in this particular instance, it should be noted that the methodology that has been utilised here is relatively amenable to modification for solving other problems of interest. These could usefully involve multiple interacting notches and multiple interacting cracks, should such geometries be deemed to be of sufficient interest.

The programs and other files associated with this work are located in Objective Folder ID fAV810973.

12. Acknowledgement

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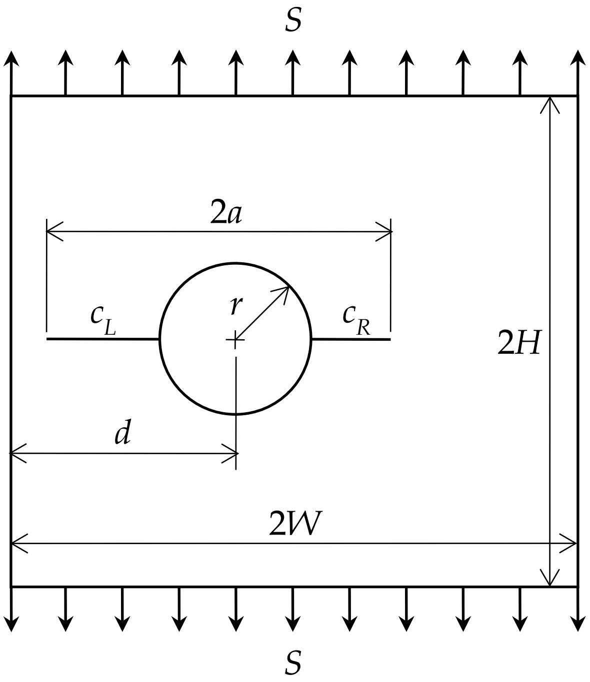


Figure 1: *Geometry for two asymmetrical collinear cracks emanating from an offset circular hole in a finite plate subjected to a uniform uniaxial remote tension stress.*

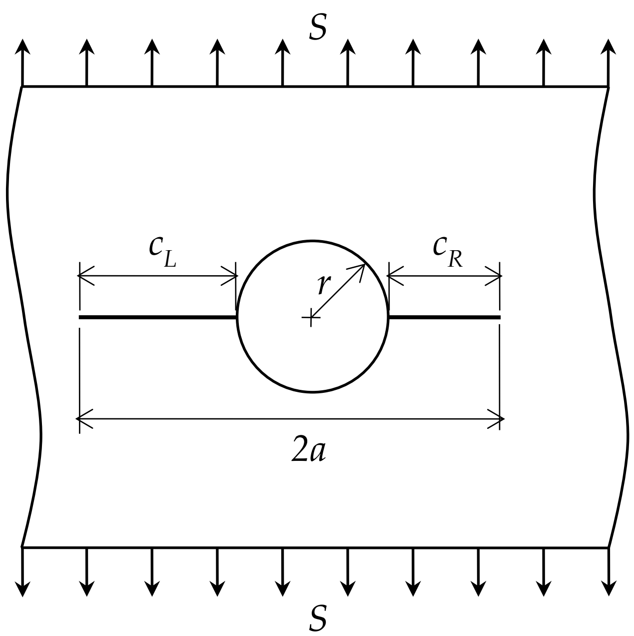
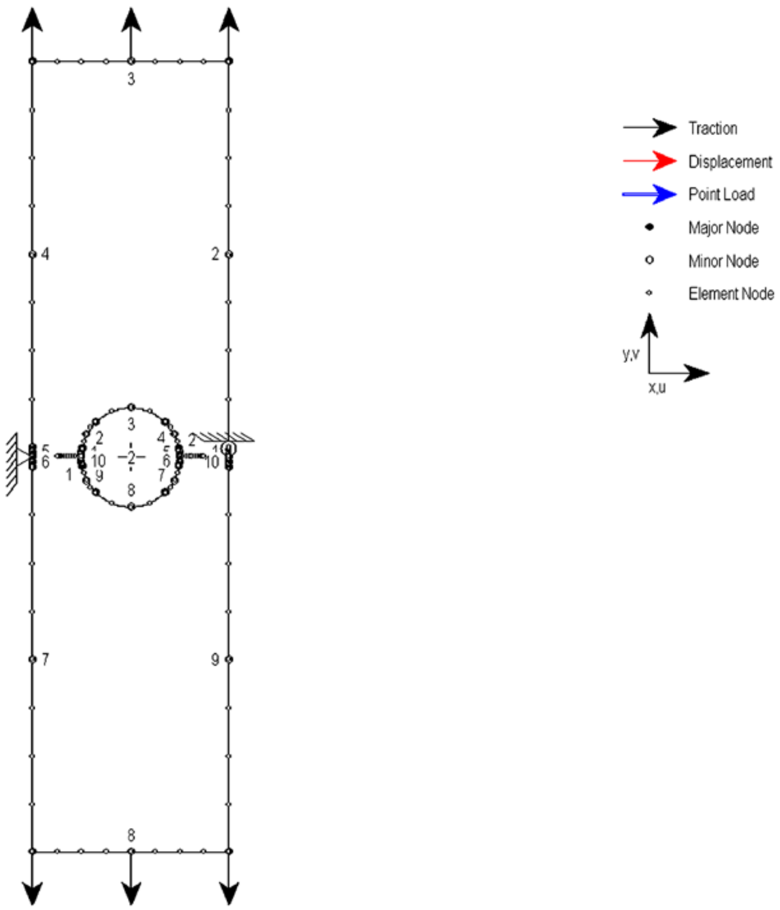
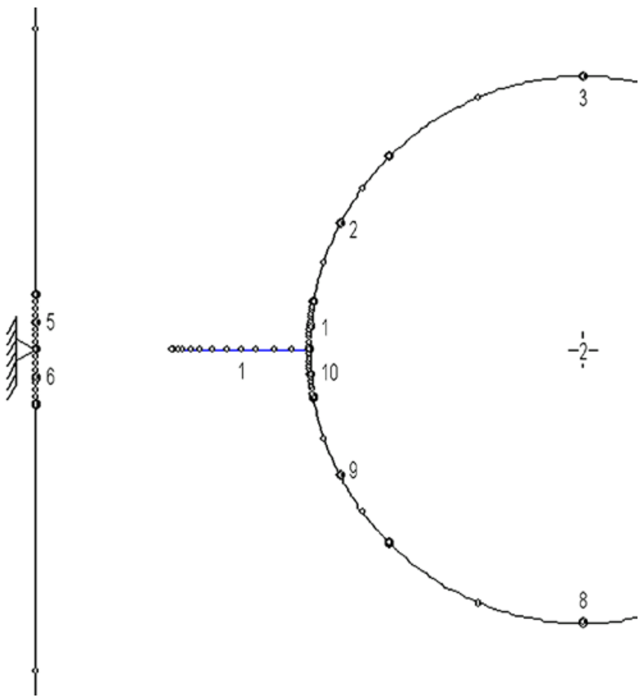


Figure 2: *Geometry for two asymmetrical collinear through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress.*

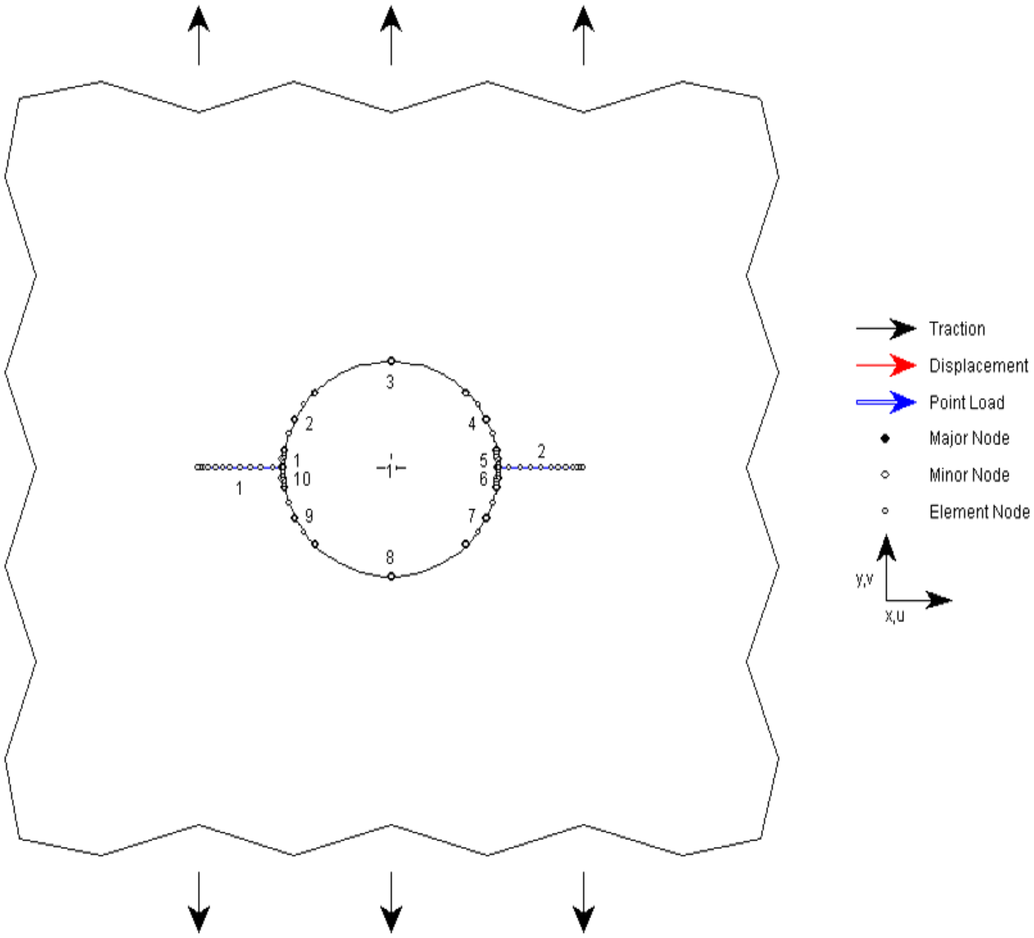


(a)

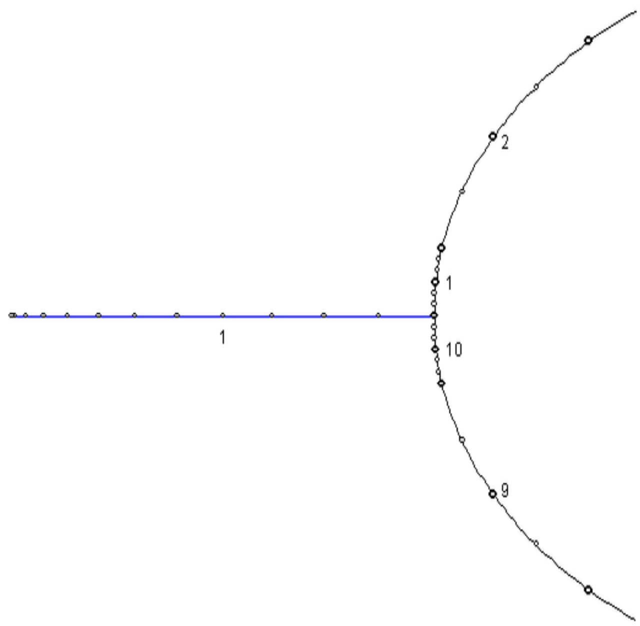


(b)

Figure 3: *FADD2D boundary element mesh for two asymmetrical collinear cracks emanating from a centrally-located circular hole in a finite plate subjected to a uniform uniaxial remote tension stress. (a) Complete model. (b) Zoomed-in view in vicinity of left-hand crack.*



(a)



(b)

Figure 4: *FADD2D boundary element mesh for two asymmetrical collinear through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress. (a) Complete model. (b) Zoomed-in view in vicinity of left-hand crack.*

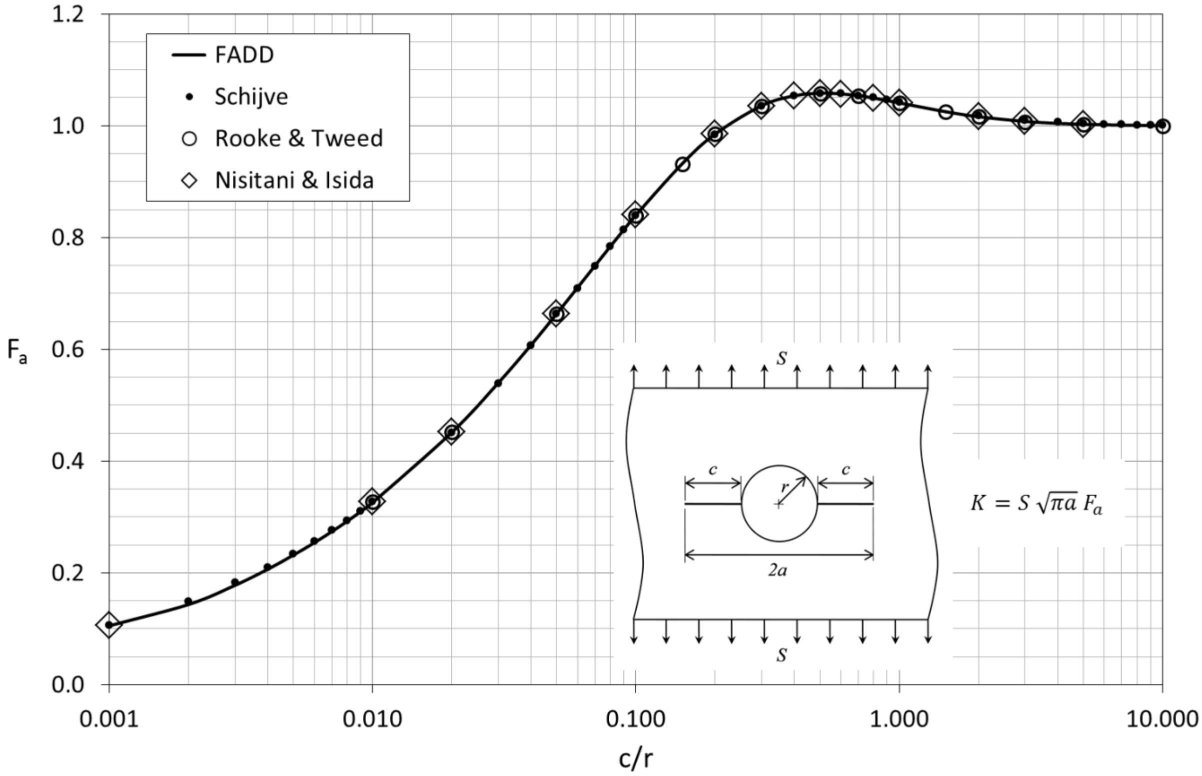


Figure 5: *Beta factor F_a for two equal collinear through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress.*

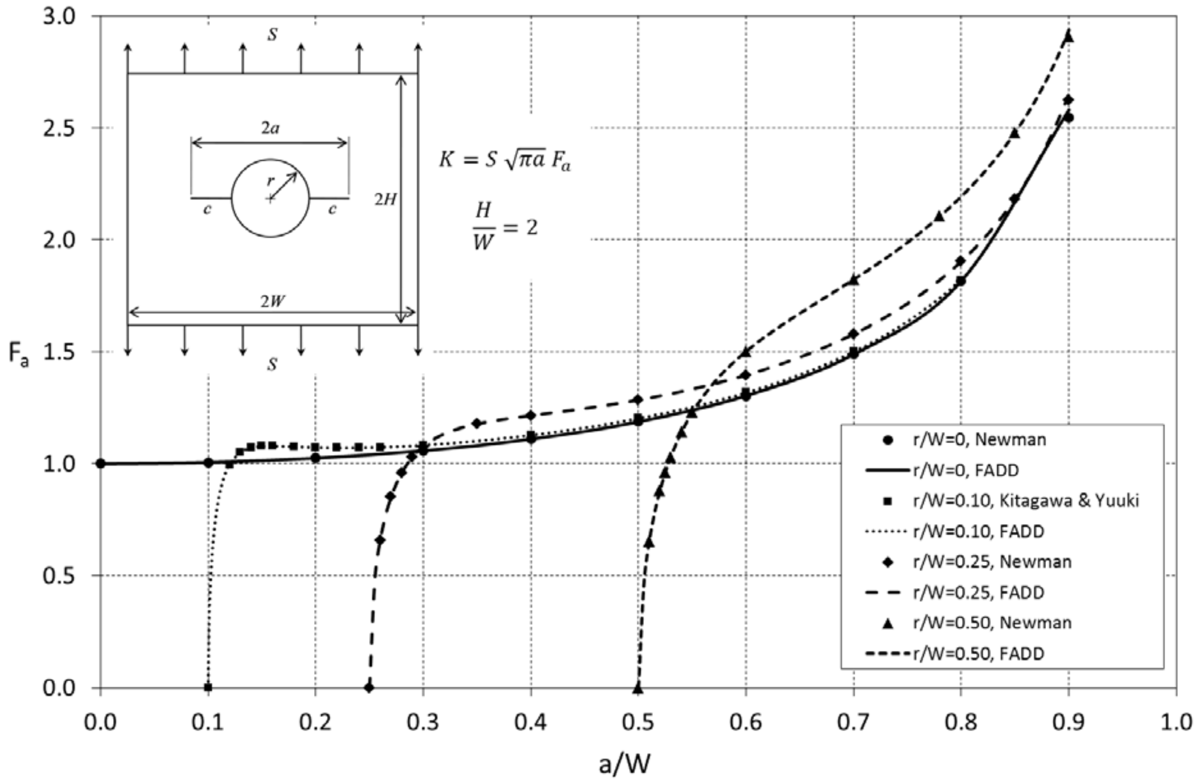


Figure 6: *Beta factors F_a for two equal collinear through cracks emanating from a central circular hole in a finite plate subjected to a uniform uniaxial remote tension stress.*

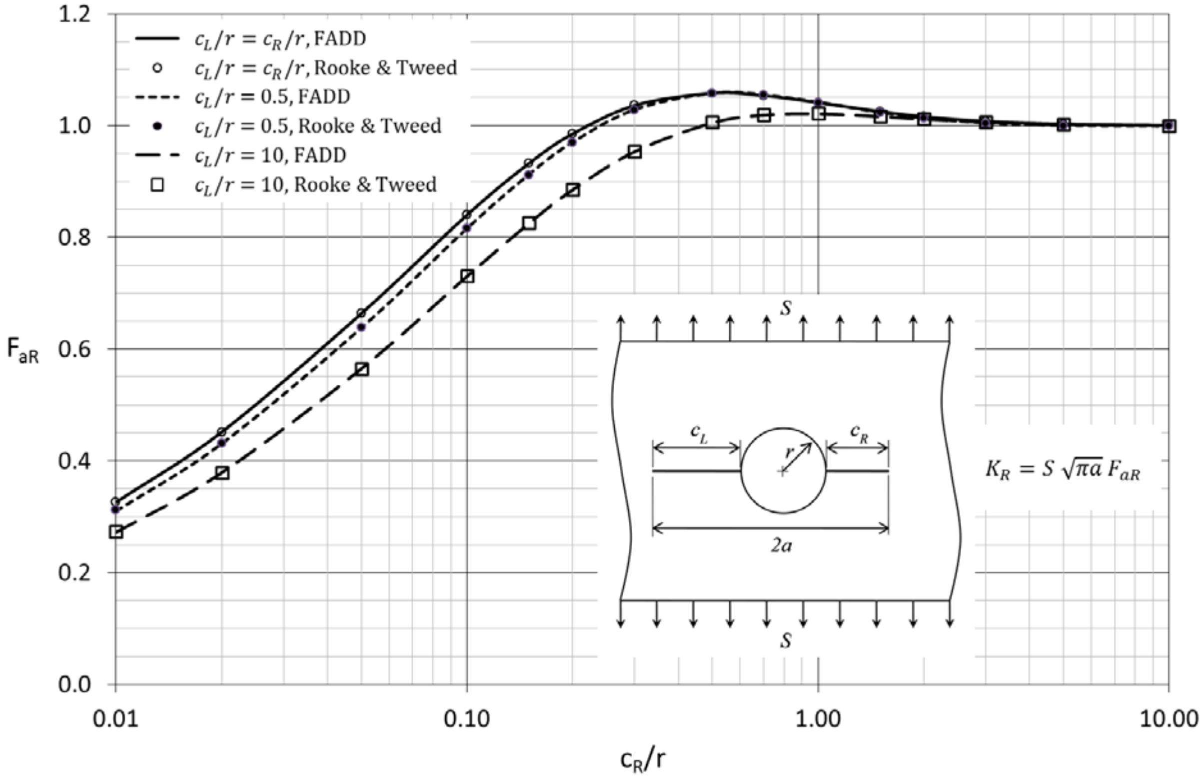


Figure 7: *Beta factors F_{aR} for the right-hand crack of two collinear through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress, for cases of equal as well as asymmetrical crack lengths.*

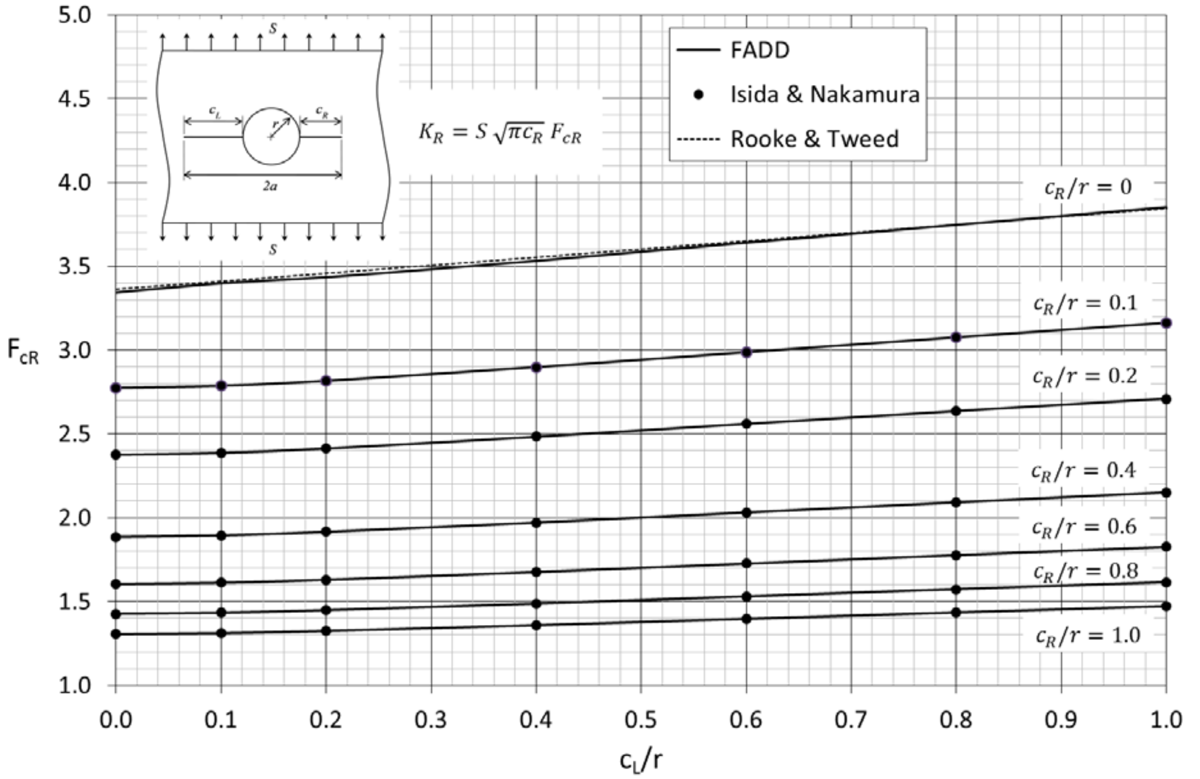


Figure 8: *Beta factors F_{cR} for the right-hand crack of two collinear unequal through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress.*

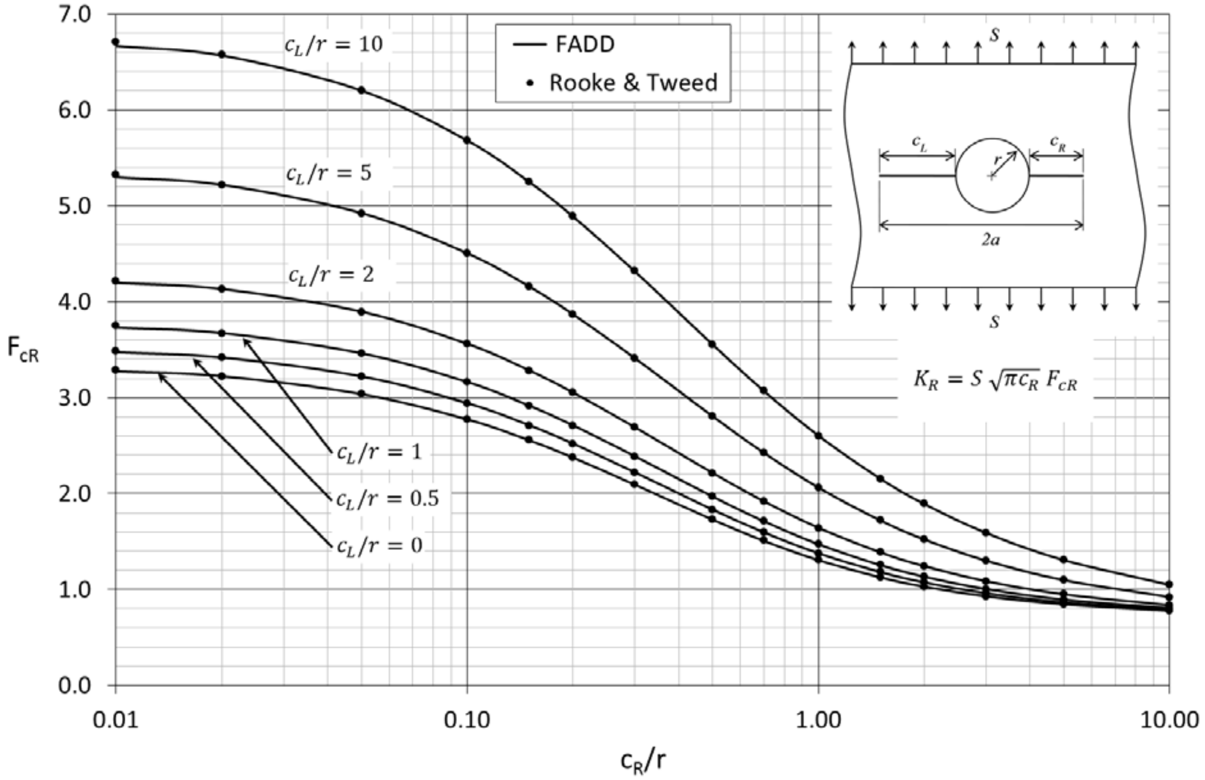


Figure 9: *Beta factors F_{cR} for the right-hand crack of two collinear unequal through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress.*

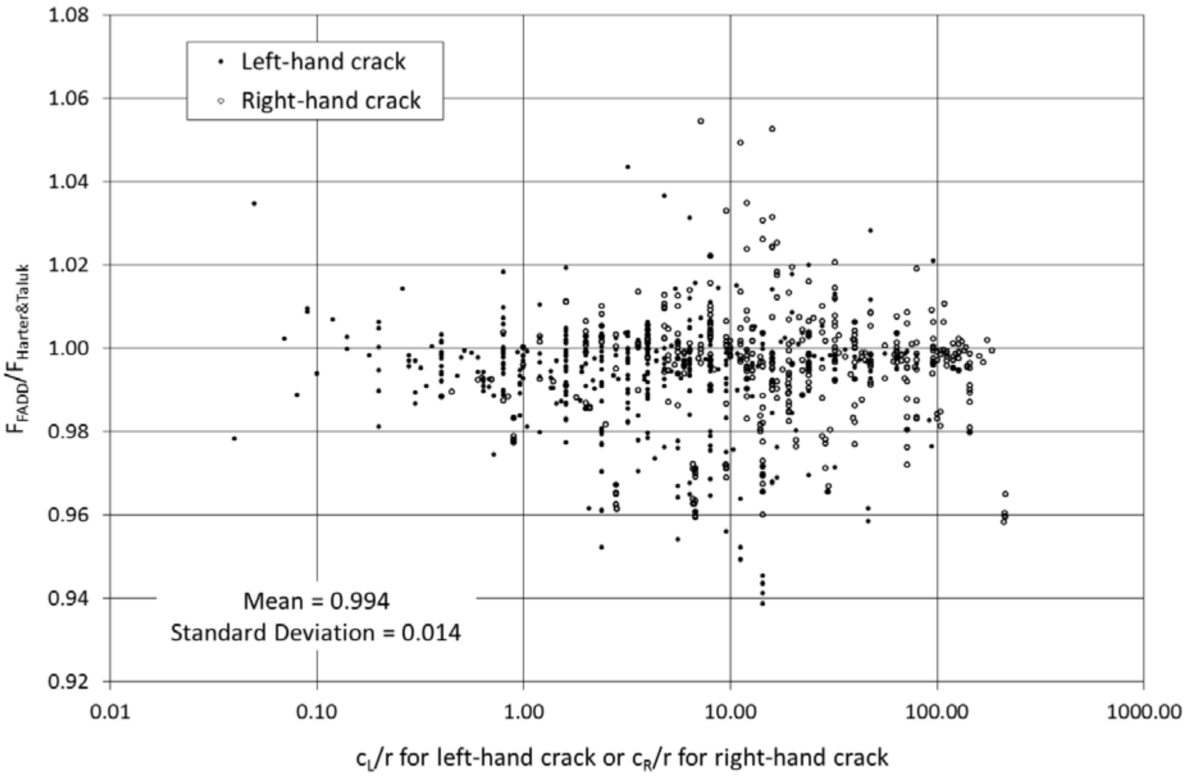


Figure 10: *Ratio of Beta factors computed by FADD2D and Harter and Taluk [10] for various crack lengths and offset hole geometries for the finite-width plate cases described in [10].*

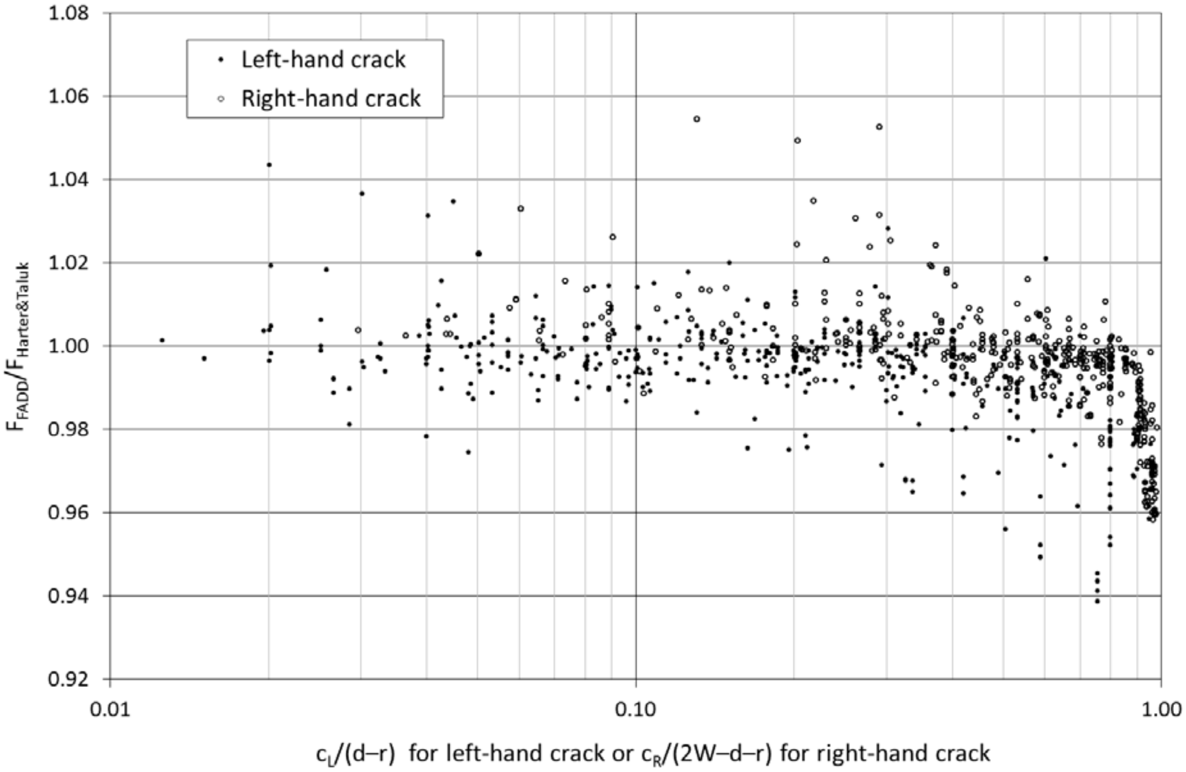


Figure 11: *Ratio of Beta factors computed by FADD2D and Harter and Taluk [10] as a function of the ratio of crack length to uncracked ligament length for various crack lengths and offset hole geometries for the finite-width plate cases described in [10].*

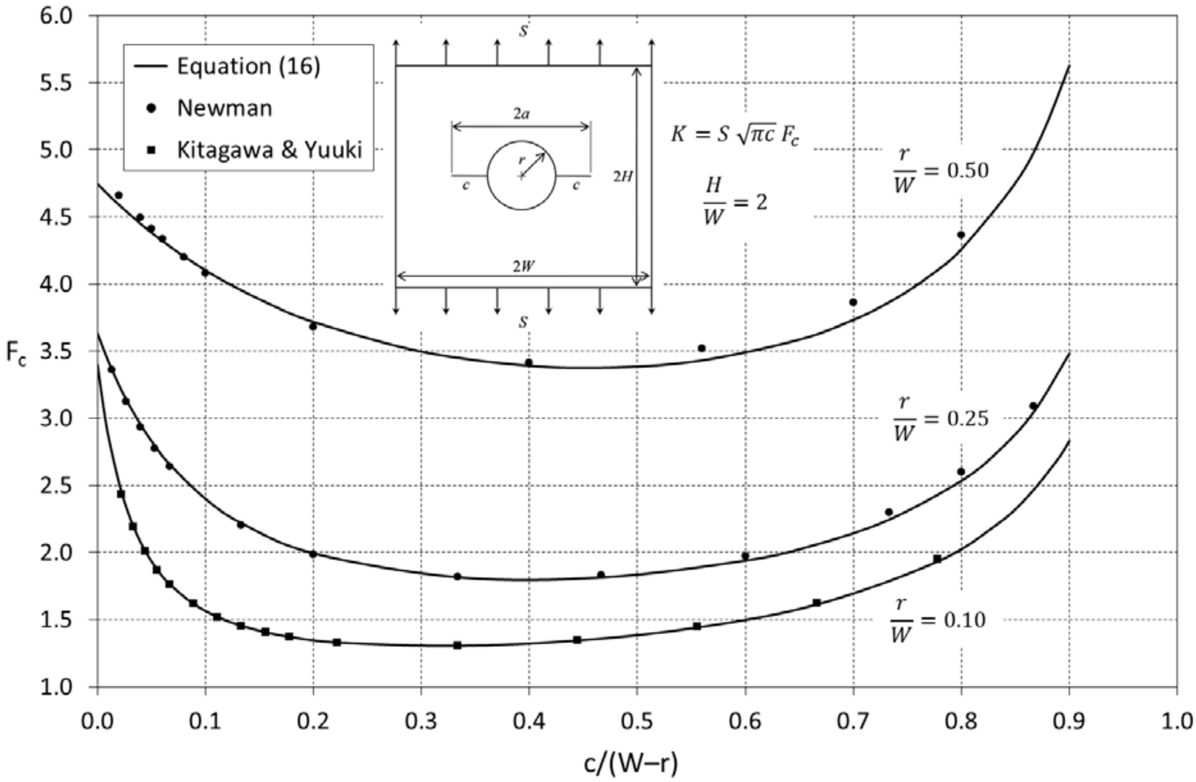


Figure 12: *Beta factors F_c for two equal collinear through cracks emanating from a central circular hole in finite-width plates subjected to a uniform uniaxial remote tension stress for various r/W ratios.*

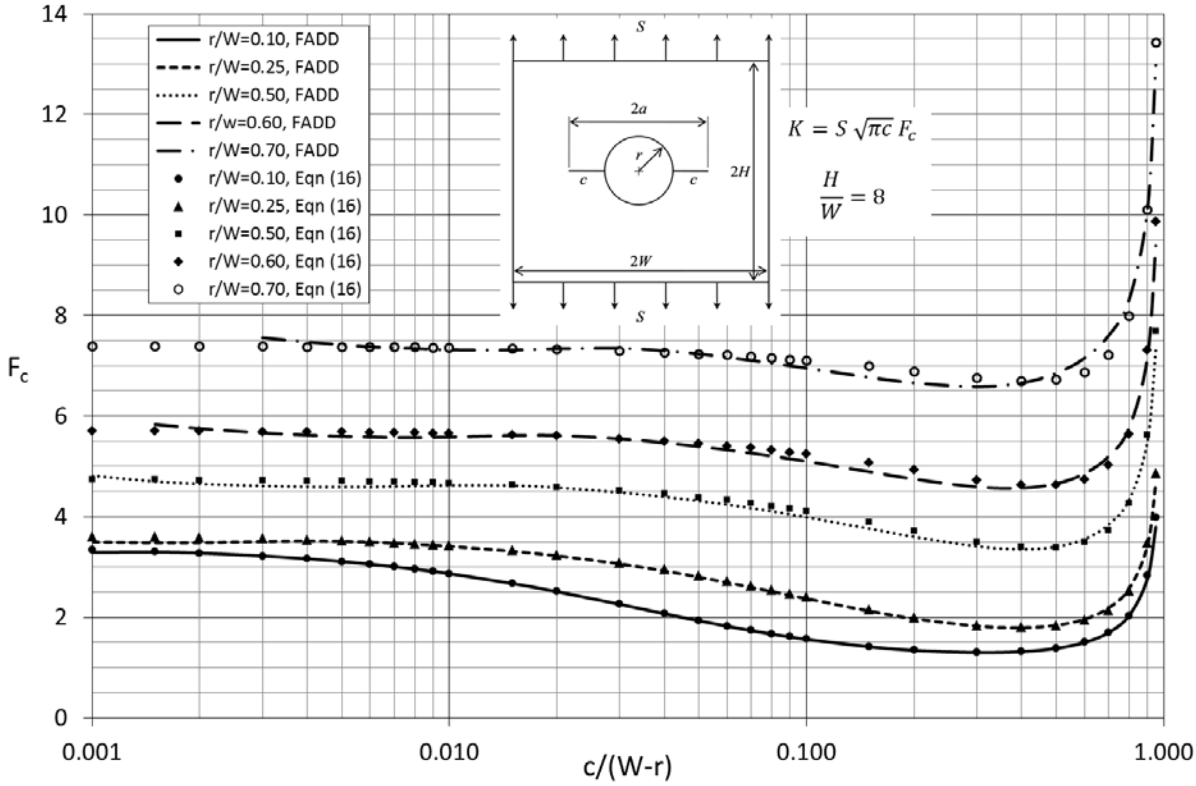


Figure 13: *Beta factors F_c for two equal collinear through cracks emanating from a central circular hole in finite-width plates subjected to a uniform uniaxial remote tension stress for various r/W ratios.*

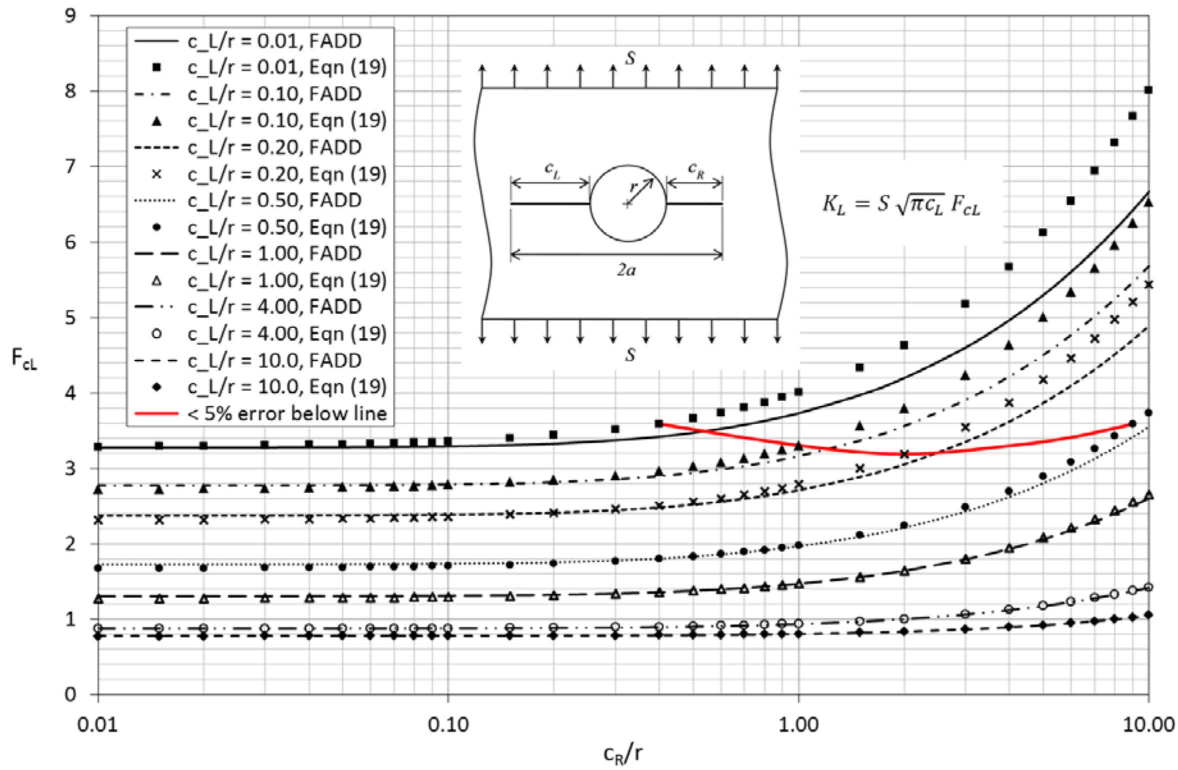


Figure 14: *Beta factors F_{cL} for the left-hand crack of two collinear unequal through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress.*

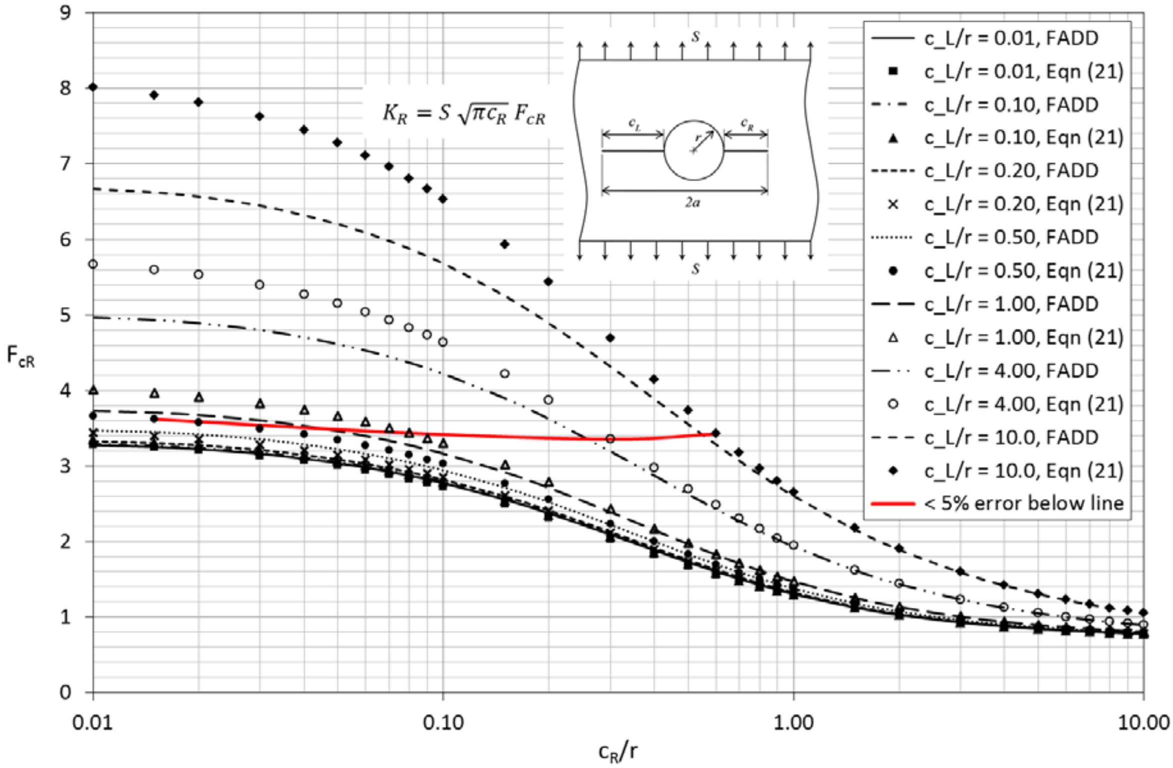


Figure 15: *Beta factors F_{cR} for the right-hand crack of two collinear unequal through cracks emanating from a circular hole in an infinite plate subjected to a uniform uniaxial remote tension stress.*

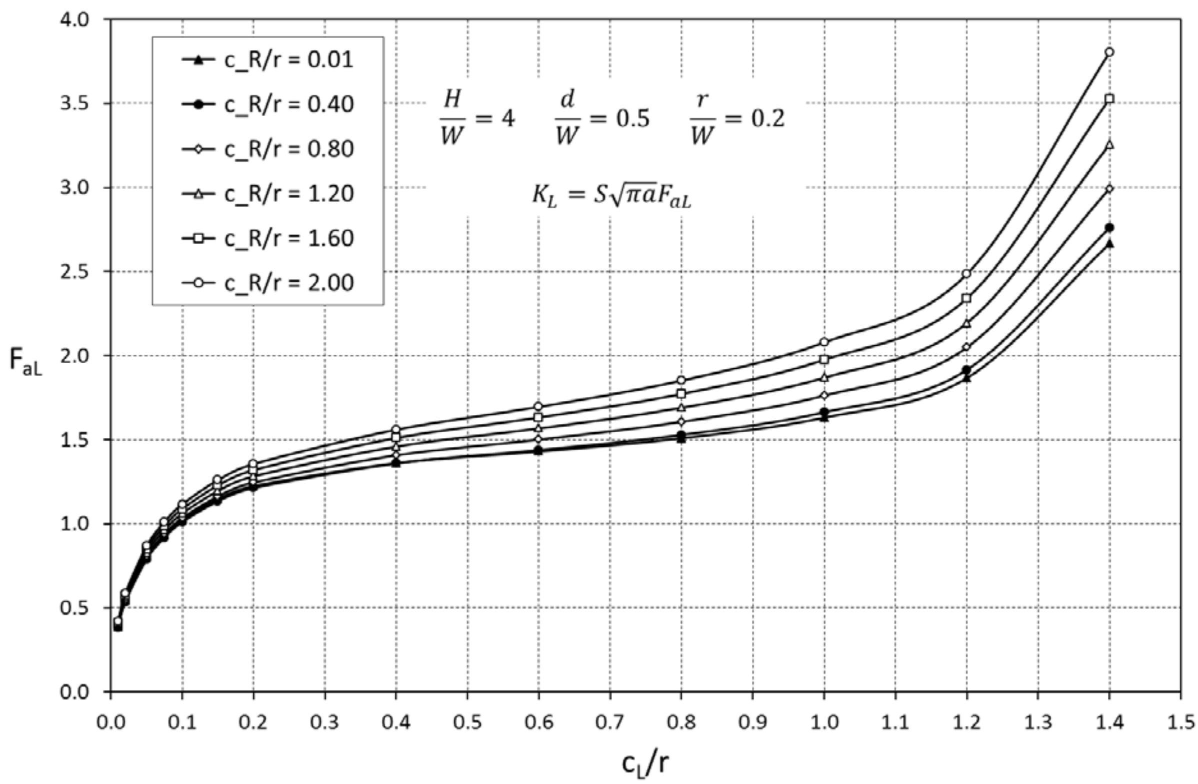


Figure 16: *Beta factors F_{aL} for the left-hand crack of two collinear unequal through cracks emanating from an offset circular hole ($r/W = 0.2$, $d/W = 0.5$) in a finite plate ($H/W = 4$) subjected to a uniform uniaxial remote tension stress.*

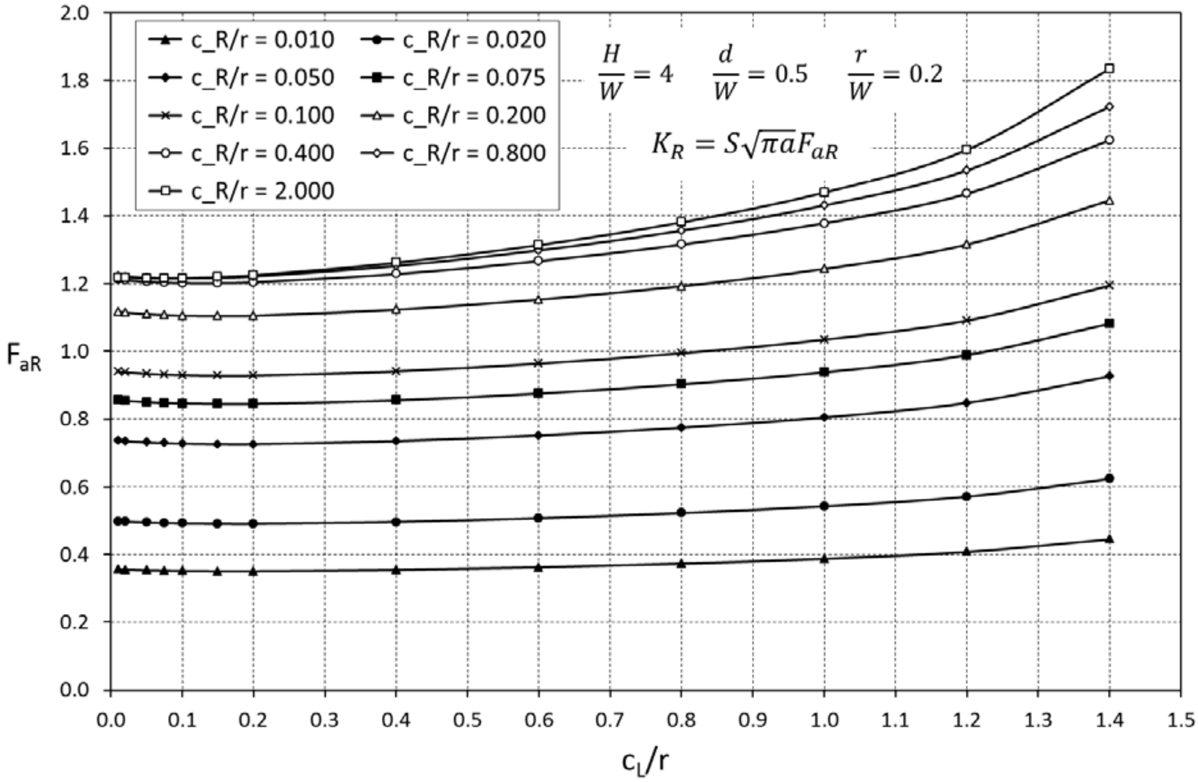


Figure 17: *Beta factors F_{aR} for the right-hand crack of two collinear unequal through cracks emanating from an offset circular hole (r/W = 0.2, d/W = 0.5) in a finite plate (H/W = 4) subjected to a uniform uniaxial remote tension stress.*

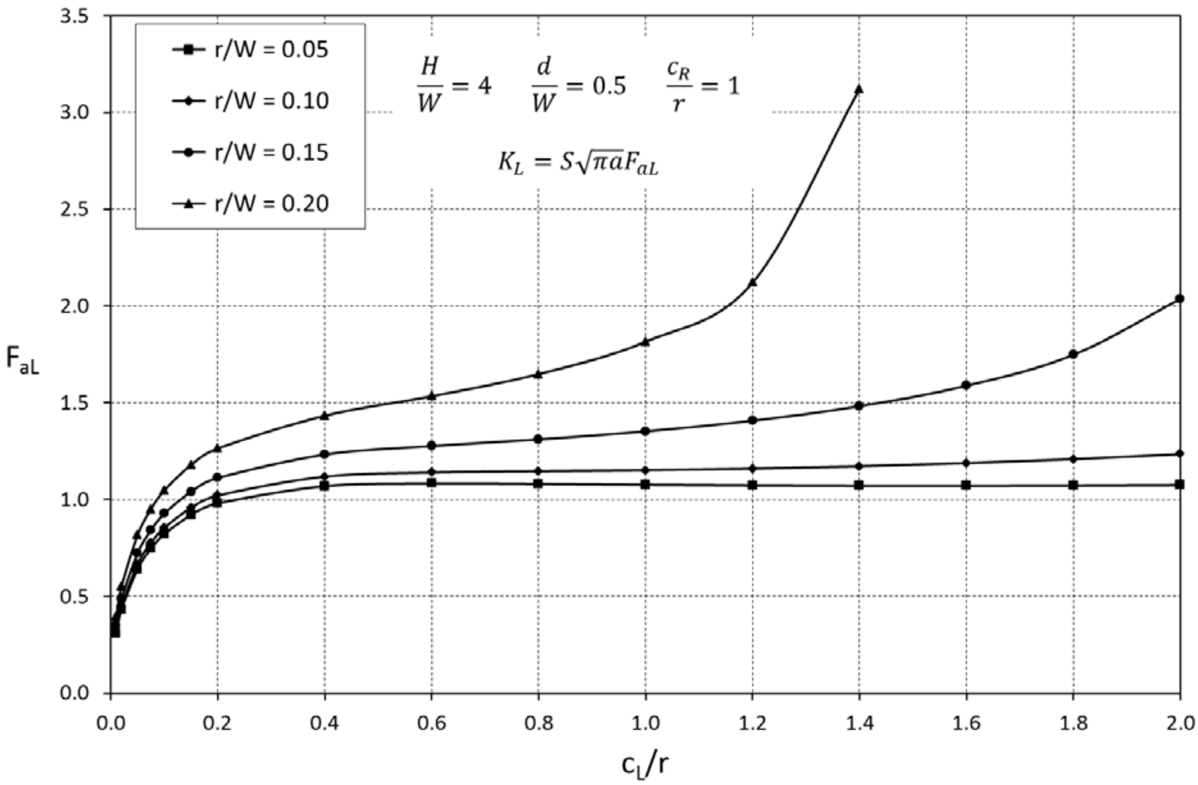


Figure 18: *Beta factors F_{aL} for the left-hand crack of two collinear unequal through cracks emanating from an offset circular hole (d/W = 0.5) in a finite plate (H/W = 4) subjected to a uniform uniaxial remote tension stress, for the case where $c_R/r = 1$ and various values of r/W.*

Table 1: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.10$ and $r/W = 0.05$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.398	0.398	0.395	0.394	0.393	0.391	0.390	0.389	0.390	0.393	0.396	0.399	0.402	0.406	0.409	0.413
	0.02	0.554	0.552	0.549	0.547	0.545	0.543	0.541	0.540	0.542	0.546	0.550	0.555	0.559	0.564	0.569	0.574
	0.05	0.817	0.815	0.810	0.807	0.805	0.801	0.799	0.798	0.801	0.807	0.813	0.820	0.827	0.835	0.842	0.850
	0.075	0.947	0.945	0.940	0.937	0.934	0.930	0.927	0.926	0.931	0.938	0.946	0.954	0.962	0.971	0.980	0.989
	0.1	1.041	1.039	1.033	1.029	1.026	1.022	1.019	1.019	1.024	1.032	1.041	1.051	1.060	1.070	1.080	1.091
	0.15	1.164	1.161	1.155	1.151	1.148	1.144	1.141	1.141	1.149	1.159	1.169	1.181	1.193	1.204	1.216	1.228
	0.2	1.240	1.238	1.231	1.227	1.224	1.220	1.217	1.218	1.227	1.239	1.251	1.265	1.278	1.291	1.305	1.319
	0.4	1.374	1.371	1.365	1.361	1.358	1.354	1.353	1.359	1.373	1.391	1.409	1.428	1.447	1.466	1.485	1.504
	0.6	1.449	1.447	1.441	1.437	1.434	1.431	1.431	1.441	1.461	1.483	1.507	1.531	1.555	1.579	1.603	1.627
	0.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.348	0.485	0.718	0.834	0.917	1.024	1.087	1.178	1.188	1.184	1.178	1.173	1.171	1.170	1.171	1.172
	0.02	0.347	0.484	0.716	0.832	0.915	1.022	1.085	1.176	1.186	1.182	1.176	1.172	1.170	1.169	1.170	1.171
	0.05	0.345	0.481	0.713	0.828	0.910	1.017	1.080	1.171	1.182	1.178	1.173	1.169	1.167	1.167	1.167	1.169
	0.075	0.344	0.480	0.711	0.826	0.908	1.014	1.078	1.169	1.180	1.177	1.172	1.168	1.166	1.166	1.167	1.169
	0.1	0.344	0.479	0.709	0.824	0.906	1.012	1.076	1.167	1.179	1.176	1.172	1.168	1.166	1.166	1.167	1.169
	0.15	0.343	0.477	0.708	0.822	0.904	1.011	1.075	1.167	1.180	1.178	1.173	1.170	1.169	1.169	1.170	1.172
	0.2	0.343	0.477	0.707	0.822	0.905	1.012	1.076	1.170	1.183	1.182	1.178	1.175	1.174	1.174	1.175	1.178
	0.4	0.346	0.482	0.715	0.832	0.916	1.025	1.092	1.192	1.210	1.210	1.208	1.206	1.206	1.207	1.209	1.211
	0.6	0.352	0.491	0.729	0.849	0.935	1.049	1.118	1.227	1.249	1.252	1.251	1.251	1.251	1.253	1.255	1.258
	0.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 2: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.20$ and $r/W = 0.05$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.339	0.339	0.337	0.335	0.334	0.332	0.331	0.327	0.326	0.325	0.325	0.325	0.325	0.325	0.326	0.326
	0.02	0.473	0.472	0.469	0.467	0.465	0.462	0.460	0.456	0.454	0.453	0.453	0.453	0.453	0.453	0.454	0.454
	0.05	0.699	0.698	0.694	0.691	0.689	0.685	0.682	0.675	0.673	0.672	0.672	0.672	0.672	0.673	0.674	0.675
	0.075	0.812	0.810	0.806	0.802	0.800	0.795	0.792	0.785	0.783	0.782	0.782	0.782	0.783	0.784	0.785	0.787
	0.1	0.892	0.890	0.885	0.882	0.879	0.874	0.870	0.863	0.861	0.860	0.861	0.861	0.862	0.864	0.865	0.867
	0.15	0.995	0.993	0.988	0.984	0.981	0.976	0.972	0.965	0.963	0.963	0.964	0.965	0.967	0.969	0.972	0.974
	0.2	1.056	1.054	1.048	1.044	1.041	1.036	1.032	1.026	1.025	1.026	1.027	1.029	1.032	1.034	1.037	1.040
c_L/r	0.4	1.141	1.139	1.133	1.130	1.127	1.122	1.119	1.115	1.117	1.121	1.125	1.129	1.134	1.139	1.143	1.148
	0.6	1.150	1.148	1.144	1.140	1.138	1.134	1.131	1.130	1.134	1.139	1.146	1.152	1.158	1.164	1.171	1.177
	0.8	1.149	1.147	1.142	1.139	1.137	1.134	1.132	1.132	1.138	1.145	1.152	1.160	1.167	1.175	1.183	1.190
	1.0	1.148	1.146	1.142	1.140	1.138	1.135	1.133	1.135	1.142	1.150	1.159	1.167	1.176	1.185	1.194	1.202
	1.2	1.153	1.151	1.147	1.145	1.143	1.140	1.139	1.142	1.150	1.159	1.169	1.179	1.188	1.198	1.208	1.218
	1.4	1.163	1.162	1.158	1.156	1.154	1.152	1.151	1.155	1.164	1.174	1.185	1.196	1.206	1.217	1.228	1.239
	1.6	1.182	1.180	1.177	1.175	1.173	1.171	1.170	1.175	1.185	1.196	1.208	1.220	1.232	1.243	1.255	1.267
	1.8	1.209	1.208	1.204	1.202	1.201	1.199	1.199	1.204	1.215	1.227	1.240	1.253	1.266	1.279	1.292	1.306
	2.0	1.249	1.248	1.244	1.242	1.241	1.240	1.239	1.246	1.258	1.271	1.285	1.300	1.314	1.329	1.343	1.358

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.333	0.466	0.688	0.799	0.878	0.980	1.040	1.122	1.127	1.119	1.110	1.103	1.098	1.095	1.093	1.092
	0.02	0.332	0.465	0.687	0.798	0.876	0.978	1.038	1.120	1.125	1.118	1.109	1.102	1.097	1.094	1.092	1.091
	0.05	0.330	0.462	0.683	0.793	0.871	0.973	1.033	1.114	1.121	1.113	1.105	1.098	1.093	1.090	1.089	1.088
	0.075	0.328	0.460	0.680	0.790	0.868	0.969	1.029	1.111	1.117	1.110	1.102	1.096	1.091	1.088	1.087	1.087
	0.1	0.327	0.459	0.678	0.787	0.865	0.966	1.026	1.108	1.115	1.108	1.100	1.094	1.090	1.087	1.086	1.085
	0.15	0.325	0.456	0.674	0.783	0.860	0.961	1.021	1.104	1.111	1.105	1.098	1.092	1.088	1.085	1.084	1.084
	0.2	0.324	0.454	0.671	0.780	0.857	0.958	1.018	1.101	1.109	1.104	1.097	1.091	1.087	1.085	1.084	1.084
c_L/r	0.4	0.321	0.450	0.666	0.774	0.851	0.952	1.012	1.099	1.109	1.105	1.099	1.094	1.091	1.089	1.089	1.089
	0.6	0.320	0.448	0.664	0.772	0.849	0.951	1.012	1.102	1.114	1.112	1.107	1.103	1.100	1.098	1.098	1.099
	0.8	0.320	0.448	0.664	0.772	0.850	0.952	1.014	1.107	1.121	1.120	1.116	1.112	1.110	1.109	1.109	1.110
	1.0	0.320	0.448	0.664	0.774	0.851	0.955	1.018	1.113	1.130	1.130	1.126	1.123	1.121	1.121	1.121	1.122
	1.2	0.320	0.449	0.666	0.776	0.854	0.959	1.022	1.120	1.139	1.140	1.137	1.135	1.134	1.133	1.134	1.136
	1.4	0.321	0.451	0.668	0.779	0.858	0.963	1.028	1.129	1.149	1.152	1.150	1.148	1.147	1.147	1.148	1.150
	1.6	0.323	0.453	0.672	0.783	0.863	0.969	1.035	1.139	1.161	1.165	1.164	1.163	1.162	1.163	1.164	1.166
	1.8	0.325	0.456	0.676	0.788	0.869	0.977	1.044	1.151	1.175	1.179	1.179	1.179	1.179	1.180	1.182	1.184
	2.0	0.327	0.459	0.682	0.795	0.877	0.986	1.054	1.165	1.191	1.197	1.198	1.198	1.199	1.200	1.203	1.205

Table 3: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.20$ and $r/W = 0.10$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.402	0.401	0.399	0.398	0.397	0.395	0.394	0.395	0.399	0.404	0.410	0.415	0.421	0.427	0.434	0.440
	0.02	0.562	0.561	0.558	0.556	0.555	0.553	0.552	0.553	0.559	0.566	0.573	0.581	0.590	0.598	0.607	0.616
	0.05	0.828	0.826	0.822	0.819	0.817	0.814	0.813	0.815	0.824	0.834	0.846	0.858	0.871	0.884	0.897	0.910
	0.075	0.960	0.958	0.953	0.950	0.948	0.945	0.943	0.947	0.957	0.970	0.983	0.998	1.013	1.028	1.043	1.059
	0.1	1.055	1.053	1.047	1.044	1.041	1.038	1.036	1.041	1.052	1.067	1.082	1.099	1.115	1.132	1.150	1.168
	0.15	1.180	1.178	1.172	1.168	1.166	1.162	1.161	1.167	1.181	1.198	1.217	1.236	1.256	1.276	1.296	1.317
	0.2	1.258	1.256	1.250	1.246	1.243	1.240	1.238	1.246	1.263	1.282	1.303	1.325	1.347	1.369	1.392	1.416
c_L/r	0.4	1.396	1.394	1.388	1.384	1.382	1.379	1.379	1.393	1.417	1.444	1.473	1.502	1.532	1.563	1.593	1.625
	0.6	1.483	1.480	1.475	1.471	1.469	1.468	1.469	1.488	1.519	1.553	1.589	1.627	1.664	1.703	1.742	1.781
	0.8	1.673	1.671	1.665	1.662	1.660	1.659	1.661	1.688	1.727	1.772	1.819	1.868	1.918	1.969	2.021	2.074
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.356	0.497	0.735	0.855	0.940	1.050	1.117	1.213	1.229	1.229	1.227	1.227	1.228	1.231	1.236	1.241
	0.02	0.355	0.496	0.734	0.853	0.938	1.048	1.115	1.211	1.227	1.227	1.226	1.225	1.227	1.230	1.234	1.240
	0.05	0.353	0.494	0.730	0.849	0.933	1.044	1.110	1.207	1.223	1.224	1.223	1.223	1.225	1.228	1.233	1.238
	0.075	0.352	0.492	0.728	0.847	0.931	1.041	1.107	1.205	1.221	1.222	1.222	1.222	1.224	1.228	1.233	1.238
	0.1	0.352	0.491	0.727	0.845	0.929	1.040	1.106	1.204	1.221	1.222	1.222	1.223	1.225	1.229	1.234	1.239
	0.15	0.351	0.491	0.726	0.844	0.928	1.039	1.105	1.205	1.223	1.225	1.225	1.226	1.229	1.233	1.238	1.244
	0.2	0.351	0.491	0.726	0.845	0.929	1.040	1.107	1.208	1.227	1.230	1.231	1.232	1.235	1.240	1.246	1.252
c_L/r	0.4	0.356	0.497	0.736	0.857	0.944	1.058	1.127	1.236	1.260	1.266	1.269	1.273	1.278	1.284	1.291	1.299
	0.6	0.364	0.509	0.754	0.879	0.968	1.086	1.160	1.278	1.307	1.318	1.324	1.330	1.337	1.345	1.354	1.364
	0.8	0.376	0.526	0.780	0.910	1.003	1.128	1.206	1.336	1.372	1.388	1.398	1.408	1.418	1.429	1.441	1.453
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 4: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters H/W = 4.00, d/W = 0.20 and r/W = 0.15.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.580	0.579	0.576	0.574	0.573	0.573	0.574	0.585	0.602	0.622	0.643	0.665	0.688	0.711	0.735	0.759
	0.02	0.807	0.806	0.802	0.800	0.798	0.798	0.799	0.815	0.839	0.867	0.896	0.927	0.958	0.991	1.024	1.058
	0.05	1.199	1.196	1.190	1.187	1.186	1.185	1.187	1.211	1.248	1.290	1.335	1.381	1.429	1.478	1.528	1.579
	0.075	1.412	1.409	1.403	1.399	1.397	1.396	1.399	1.429	1.473	1.524	1.578	1.633	1.691	1.750	1.810	1.872
	0.1	1.577	1.574	1.567	1.563	1.561	1.560	1.564	1.598	1.649	1.707	1.769	1.833	1.899	1.967	2.037	2.108
	0.15	1.818	1.815	1.807	1.803	1.801	1.801	1.805	1.848	1.911	1.982	2.058	2.137	2.219	2.303	2.390	2.478
	0.2	1.983	1.979	1.971	1.967	1.965	1.966	1.971	2.023	2.096	2.180	2.269	2.363	2.459	2.559	2.662	2.767
	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	0.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.394	0.551	0.815	0.948	1.044	1.170	1.247	1.372	1.406	1.421	1.433	1.445	1.458	1.473	1.488	1.504
	0.02	0.393	0.550	0.814	0.947	1.042	1.168	1.246	1.370	1.404	1.420	1.432	1.444	1.458	1.472	1.488	1.504
	0.05	0.392	0.549	0.812	0.946	1.040	1.167	1.244	1.370	1.405	1.421	1.434	1.447	1.461	1.476	1.492	1.509
	0.075	0.393	0.550	0.814	0.947	1.042	1.169	1.247	1.374	1.410	1.427	1.441	1.455	1.469	1.485	1.502	1.519
	0.1	0.394	0.551	0.817	0.951	1.046	1.174	1.253	1.382	1.419	1.438	1.452	1.466	1.482	1.498	1.516	1.534
	0.15	0.399	0.559	0.828	0.964	1.061	1.191	1.272	1.406	1.447	1.468	1.485	1.501	1.519	1.537	1.556	1.576
	0.2	0.407	0.569	0.843	0.982	1.082	1.216	1.299	1.440	1.485	1.510	1.529	1.549	1.569	1.590	1.612	1.635
	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	0.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 5: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.30$ and $r/W = 0.05$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.331	0.330	0.328	0.326	0.325	0.323	0.322	0.318	0.315	0.314	0.313	0.312	0.311	0.311	0.310	0.310
	0.02	0.463	0.462	0.459	0.457	0.456	0.453	0.451	0.445	0.442	0.440	0.439	0.438	0.437	0.436	0.435	0.435
	0.05	0.684	0.683	0.679	0.676	0.673	0.669	0.666	0.658	0.654	0.652	0.650	0.648	0.647	0.646	0.646	0.645
	0.075	0.794	0.793	0.788	0.785	0.782	0.777	0.774	0.765	0.761	0.758	0.756	0.755	0.754	0.753	0.752	0.752
	0.1	0.872	0.870	0.865	0.862	0.859	0.854	0.850	0.841	0.837	0.834	0.832	0.831	0.830	0.829	0.829	0.829
	0.15	0.974	0.972	0.966	0.962	0.959	0.954	0.950	0.941	0.937	0.935	0.933	0.932	0.931	0.931	0.931	0.931
	0.2	1.033	1.031	1.025	1.022	1.018	1.013	1.009	1.000	0.997	0.995	0.994	0.993	0.993	0.993	0.994	0.994
	0.4	1.114	1.112	1.106	1.102	1.099	1.095	1.091	1.085	1.084	1.084	1.086	1.087	1.088	1.090	1.092	1.094
	0.6	1.119	1.118	1.113	1.109	1.107	1.102	1.100	1.096	1.096	1.099	1.101	1.104	1.107	1.110	1.113	1.116
	0.8	1.112	1.111	1.106	1.103	1.101	1.097	1.095	1.092	1.094	1.098	1.102	1.105	1.109	1.113	1.117	1.121
	1.0	1.105	1.103	1.099	1.096	1.094	1.091	1.089	1.088	1.091	1.095	1.100	1.104	1.109	1.113	1.118	1.122
	1.2	1.100	1.099	1.095	1.092	1.090	1.087	1.086	1.085	1.089	1.094	1.099	1.104	1.109	1.115	1.120	1.125
	1.4	1.098	1.097	1.093	1.091	1.089	1.086	1.085	1.085	1.089	1.095	1.100	1.106	1.112	1.118	1.123	1.129
	1.6	1.099	1.097	1.094	1.092	1.090	1.088	1.087	1.087	1.092	1.098	1.104	1.110	1.117	1.123	1.129	1.135
	1.8	1.102	1.100	1.097	1.095	1.094	1.092	1.090	1.092	1.097	1.103	1.110	1.117	1.123	1.130	1.136	1.143
	2.0	1.107	1.106	1.103	1.101	1.099	1.097	1.097	1.099	1.104	1.111	1.118	1.125	1.132	1.139	1.146	1.153

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.329	0.460	0.680	0.790	0.867	0.968	1.027	1.107	1.111	1.101	1.091	1.083	1.077	1.072	1.069	1.067
	0.02	0.328	0.459	0.679	0.788	0.866	0.966	1.025	1.105	1.109	1.100	1.090	1.081	1.075	1.071	1.068	1.066
	0.05	0.326	0.457	0.675	0.784	0.861	0.961	1.020	1.099	1.104	1.095	1.086	1.078	1.072	1.067	1.065	1.063
	0.075	0.325	0.455	0.672	0.781	0.857	0.957	1.016	1.096	1.101	1.092	1.083	1.075	1.069	1.065	1.063	1.061
	0.1	0.323	0.453	0.670	0.778	0.854	0.954	1.013	1.092	1.098	1.090	1.081	1.073	1.068	1.064	1.061	1.060
	0.15	0.321	0.450	0.666	0.773	0.849	0.949	1.007	1.088	1.094	1.086	1.078	1.070	1.065	1.061	1.059	1.058
	0.2	0.320	0.448	0.663	0.770	0.846	0.945	1.004	1.084	1.091	1.084	1.076	1.069	1.064	1.060	1.058	1.057
	0.4	0.316	0.443	0.655	0.762	0.837	0.936	0.995	1.079	1.088	1.082	1.075	1.069	1.064	1.061	1.059	1.058
	0.6	0.314	0.440	0.651	0.757	0.833	0.933	0.992	1.078	1.089	1.085	1.078	1.072	1.068	1.065	1.064	1.063
	0.8	0.312	0.438	0.649	0.755	0.831	0.931	0.991	1.079	1.092	1.088	1.083	1.077	1.073	1.071	1.069	1.069
	1.0	0.312	0.437	0.648	0.754	0.829	0.930	0.991	1.081	1.095	1.093	1.088	1.083	1.079	1.077	1.076	1.075
	1.2	0.311	0.436	0.647	0.753	0.829	0.930	0.991	1.084	1.099	1.098	1.093	1.089	1.085	1.083	1.082	1.082
	1.4	0.311	0.436	0.646	0.753	0.829	0.930	0.992	1.086	1.103	1.103	1.099	1.095	1.092	1.090	1.089	1.089
	1.6	0.310	0.436	0.646	0.753	0.829	0.931	0.993	1.090	1.108	1.108	1.105	1.101	1.099	1.097	1.096	1.097
	1.8	0.310	0.436	0.646	0.753	0.830	0.932	0.995	1.093	1.113	1.114	1.111	1.108	1.106	1.105	1.104	1.104
	2.0	0.311	0.436	0.647	0.754	0.831	0.934	0.998	1.098	1.118	1.120	1.118	1.115	1.114	1.113	1.112	1.113

Table 6: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.30$ and $r/W = 0.10$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.358	0.357	0.355	0.354	0.353	0.351	0.350	0.348	0.349	0.350	0.352	0.354	0.356	0.359	0.361	0.364
	0.02	0.502	0.500	0.498	0.496	0.494	0.492	0.490	0.488	0.489	0.491	0.493	0.496	0.499	0.503	0.506	0.510
	0.05	0.740	0.739	0.734	0.732	0.729	0.726	0.724	0.721	0.723	0.726	0.730	0.735	0.740	0.745	0.750	0.756
	0.075	0.859	0.857	0.853	0.850	0.847	0.843	0.841	0.838	0.840	0.844	0.849	0.855	0.861	0.867	0.874	0.880
	0.1	0.943	0.941	0.936	0.933	0.930	0.926	0.923	0.921	0.924	0.929	0.935	0.941	0.948	0.955	0.962	0.970
	0.15	1.054	1.052	1.046	1.043	1.040	1.035	1.033	1.031	1.035	1.041	1.049	1.057	1.065	1.074	1.082	1.092
	0.2	1.120	1.118	1.112	1.109	1.106	1.101	1.099	1.098	1.103	1.111	1.120	1.129	1.138	1.148	1.158	1.168
	0.4	1.220	1.218	1.213	1.209	1.206	1.203	1.201	1.204	1.214	1.226	1.239	1.252	1.265	1.279	1.293	1.307
	0.6	1.246	1.244	1.238	1.235	1.233	1.230	1.229	1.236	1.249	1.264	1.280	1.297	1.314	1.330	1.347	1.364
	0.8	1.263	1.261	1.257	1.254	1.252	1.250	1.250	1.259	1.275	1.293	1.313	1.332	1.352	1.371	1.391	1.411
	1.0	1.290	1.288	1.284	1.281	1.279	1.278	1.278	1.290	1.309	1.330	1.352	1.375	1.398	1.421	1.444	1.467
	1.2	1.334	1.332	1.328	1.326	1.324	1.323	1.324	1.338	1.360	1.385	1.410	1.436	1.463	1.489	1.516	1.543
	1.4	1.409	1.407	1.403	1.401	1.399	1.399	1.400	1.417	1.443	1.471	1.501	1.531	1.562	1.593	1.625	1.657
	1.6	1.547	1.545	1.541	1.539	1.538	1.538	1.540	1.561	1.591	1.625	1.661	1.698	1.736	1.774	1.812	1.851
	1.8	1.877	1.875	1.870	1.868	1.867	1.867	1.870	1.898	1.938	1.983	2.032	2.081	2.133	2.185	2.238	2.292
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.343	0.479	0.708	0.823	0.904	1.010	1.072	1.160	1.170	1.165	1.160	1.155	1.153	1.152	1.153	1.155
	0.02	0.342	0.478	0.706	0.821	0.902	1.008	1.070	1.158	1.168	1.164	1.158	1.154	1.152	1.151	1.152	1.154
	0.05	0.340	0.475	0.703	0.817	0.897	1.002	1.065	1.153	1.164	1.160	1.154	1.150	1.148	1.148	1.149	1.151
	0.075	0.339	0.473	0.700	0.814	0.894	0.999	1.062	1.150	1.161	1.157	1.152	1.149	1.147	1.147	1.148	1.150
	0.1	0.338	0.472	0.698	0.812	0.892	0.997	1.059	1.148	1.159	1.156	1.151	1.147	1.146	1.146	1.147	1.149
	0.15	0.336	0.470	0.695	0.808	0.889	0.993	1.056	1.145	1.157	1.154	1.150	1.147	1.146	1.146	1.148	1.150
	0.2	0.336	0.469	0.693	0.807	0.887	0.991	1.054	1.144	1.157	1.155	1.151	1.148	1.147	1.148	1.150	1.152
	0.4	0.335	0.468	0.693	0.806	0.887	0.993	1.057	1.152	1.167	1.167	1.165	1.163	1.163	1.164	1.167	1.170
	0.6	0.337	0.471	0.697	0.812	0.893	1.001	1.067	1.166	1.185	1.187	1.186	1.185	1.186	1.188	1.191	1.195
	0.8	0.340	0.475	0.704	0.820	0.903	1.013	1.080	1.184	1.206	1.210	1.211	1.212	1.213	1.216	1.220	1.225
	1.0	0.344	0.480	0.713	0.830	0.915	1.027	1.096	1.206	1.231	1.237	1.240	1.242	1.245	1.248	1.253	1.259
	1.2	0.349	0.487	0.723	0.844	0.930	1.045	1.116	1.232	1.260	1.269	1.273	1.276	1.281	1.286	1.291	1.298
	1.4	0.355	0.496	0.737	0.860	0.948	1.067	1.141	1.263	1.295	1.307	1.313	1.318	1.324	1.330	1.338	1.345
	1.6	0.364	0.509	0.756	0.882	0.973	1.096	1.173	1.303	1.341	1.355	1.364	1.372	1.380	1.388	1.397	1.406
	1.8	0.377	0.528	0.786	0.917	1.013	1.142	1.223	1.365	1.409	1.428	1.441	1.452	1.463	1.474	1.485	1.497
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 7: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.30$ and $r/W = 0.15$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.421	0.421	0.418	0.417	0.416	0.415	0.414	0.417	0.423	0.430	0.438	0.446	0.454	0.462	0.470	0.479
	0.02	0.588	0.587	0.584	0.582	0.580	0.579	0.578	0.582	0.591	0.601	0.611	0.622	0.634	0.645	0.657	0.669
	0.05	0.866	0.864	0.860	0.857	0.855	0.853	0.852	0.858	0.871	0.886	0.902	0.919	0.936	0.953	0.971	0.989
	0.075	1.005	1.003	0.998	0.995	0.993	0.990	0.989	0.997	1.013	1.031	1.050	1.069	1.090	1.110	1.131	1.152
	0.1	1.105	1.103	1.097	1.094	1.091	1.088	1.088	1.097	1.114	1.135	1.156	1.179	1.201	1.224	1.248	1.271
	0.15	1.237	1.235	1.229	1.225	1.223	1.220	1.220	1.231	1.252	1.276	1.302	1.328	1.355	1.382	1.409	1.437
	0.2	1.321	1.318	1.312	1.309	1.306	1.303	1.303	1.317	1.341	1.369	1.397	1.427	1.457	1.487	1.518	1.549
c_L/r	0.4	1.477	1.474	1.468	1.465	1.463	1.461	1.463	1.486	1.520	1.558	1.598	1.639	1.680	1.722	1.765	1.807
	0.6	1.580	1.578	1.572	1.569	1.568	1.568	1.571	1.602	1.646	1.695	1.747	1.800	1.854	1.909	1.964	2.021
	0.8	1.803	1.800	1.795	1.792	1.791	1.792	1.798	1.840	1.899	1.965	2.035	2.108	2.183	2.259	2.337	2.417
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.364	0.509	0.753	0.875	0.962	1.076	1.144	1.246	1.265	1.267	1.268	1.269	1.271	1.276	1.281	1.286
	0.02	0.363	0.508	0.751	0.873	0.960	1.074	1.142	1.244	1.263	1.266	1.266	1.267	1.270	1.274	1.279	1.285
	0.05	0.362	0.506	0.748	0.870	0.956	1.069	1.138	1.240	1.260	1.263	1.263	1.265	1.268	1.273	1.278	1.284
	0.075	0.361	0.504	0.746	0.868	0.954	1.067	1.136	1.239	1.259	1.262	1.263	1.265	1.269	1.273	1.279	1.285
	0.1	0.360	0.504	0.745	0.867	0.953	1.066	1.135	1.238	1.259	1.263	1.264	1.267	1.270	1.275	1.281	1.287
	0.15	0.360	0.503	0.745	0.867	0.953	1.067	1.136	1.241	1.263	1.268	1.270	1.273	1.277	1.282	1.288	1.295
	0.2	0.361	0.505	0.747	0.869	0.956	1.070	1.140	1.247	1.270	1.276	1.278	1.282	1.287	1.292	1.299	1.306
c_L/r	0.4	0.369	0.516	0.764	0.889	0.979	1.098	1.171	1.288	1.317	1.327	1.333	1.340	1.347	1.355	1.364	1.373
	0.6	0.381	0.533	0.790	0.921	1.015	1.140	1.218	1.347	1.383	1.399	1.410	1.420	1.431	1.442	1.454	1.466
	0.8	0.398	0.558	0.828	0.966	1.065	1.198	1.282	1.427	1.474	1.498	1.515	1.531	1.548	1.564	1.582	1.599
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 8: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.30$ and $r/W = 0.20$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.550	0.549	0.546	0.545	0.544	0.543	0.544	0.556	0.573	0.592	0.612	0.633	0.654	0.675	0.697	0.718
	0.02	0.764	0.763	0.759	0.757	0.756	0.755	0.757	0.773	0.797	0.823	0.852	0.880	0.910	0.940	0.969	1.000
	0.05	1.124	1.122	1.117	1.114	1.112	1.112	1.114	1.139	1.174	1.214	1.256	1.300	1.344	1.388	1.433	1.478
	0.075	1.309	1.307	1.301	1.298	1.296	1.296	1.298	1.328	1.370	1.418	1.468	1.520	1.572	1.625	1.679	1.732
	0.1	1.446	1.443	1.436	1.433	1.431	1.431	1.435	1.468	1.516	1.570	1.627	1.685	1.745	1.805	1.866	1.927
	0.15	1.637	1.634	1.627	1.624	1.622	1.623	1.627	1.668	1.726	1.791	1.859	1.930	2.001	2.074	2.148	2.222
	0.2	1.768	1.765	1.758	1.755	1.753	1.754	1.760	1.808	1.875	1.949	2.028	2.110	2.193	2.277	2.363	2.450
c_L/r	0.4	2.186	2.183	2.175	2.173	2.172	2.177	2.189	2.268	2.377	2.499	2.630	2.768	2.911	3.060	3.212	3.369
	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	0.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.396	0.554	0.820	0.954	1.050	1.176	1.254	1.379	1.411	1.425	1.434	1.444	1.454	1.465	1.475	1.486
	0.02	0.395	0.553	0.819	0.953	1.048	1.175	1.252	1.377	1.410	1.424	1.433	1.443	1.453	1.464	1.475	1.485
	0.05	0.394	0.552	0.817	0.951	1.046	1.172	1.250	1.376	1.410	1.424	1.435	1.445	1.456	1.467	1.478	1.489
	0.075	0.395	0.552	0.817	0.951	1.047	1.174	1.252	1.379	1.413	1.429	1.440	1.451	1.462	1.474	1.485	1.497
	0.1	0.396	0.554	0.819	0.954	1.050	1.177	1.256	1.384	1.420	1.436	1.448	1.460	1.472	1.484	1.496	1.508
	0.15	0.399	0.559	0.827	0.963	1.060	1.190	1.270	1.402	1.441	1.459	1.473	1.486	1.500	1.513	1.527	1.540
	0.2	0.405	0.566	0.839	0.977	1.076	1.207	1.290	1.427	1.469	1.490	1.506	1.522	1.537	1.552	1.568	1.583
c_L/r	0.4	0.439	0.614	0.911	1.062	1.171	1.319	1.413	1.581	1.643	1.681	1.713	1.743	1.772	1.801	1.830	1.858
	0.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	0.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 9: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters H/W = 4.00, d/W = 0.40 and r/W = 0.05.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.328	0.327	0.325	0.323	0.322	0.320	0.319	0.314	0.312	0.310	0.308	0.307	0.306	0.305	0.305	0.304
	0.02	0.459	0.458	0.455	0.453	0.452	0.449	0.446	0.440	0.437	0.435	0.433	0.431	0.430	0.428	0.427	0.426
	0.05	0.678	0.677	0.673	0.670	0.667	0.663	0.660	0.652	0.647	0.644	0.641	0.639	0.637	0.635	0.634	0.633
	0.075	0.788	0.786	0.781	0.778	0.775	0.770	0.767	0.758	0.752	0.749	0.746	0.744	0.742	0.740	0.739	0.737
	0.1	0.865	0.863	0.858	0.854	0.851	0.846	0.842	0.833	0.827	0.824	0.821	0.819	0.817	0.815	0.814	0.812
	0.15	0.965	0.963	0.958	0.954	0.951	0.945	0.941	0.931	0.926	0.923	0.920	0.918	0.917	0.915	0.914	0.913
	0.2	1.024	1.022	1.016	1.012	1.009	1.004	0.999	0.990	0.985	0.982	0.980	0.979	0.977	0.976	0.975	0.974
	0.4	1.103	1.101	1.095	1.092	1.088	1.084	1.080	1.073	1.070	1.070	1.069	1.069	1.069	1.070	1.070	1.071
	0.6	1.107	1.105	1.100	1.097	1.094	1.090	1.087	1.082	1.081	1.082	1.083	1.084	1.086	1.087	1.088	1.090
	0.8	1.098	1.097	1.092	1.089	1.086	1.083	1.080	1.077	1.077	1.079	1.081	1.083	1.085	1.088	1.090	1.092
	1.0	1.089	1.087	1.083	1.080	1.078	1.075	1.073	1.070	1.071	1.074	1.077	1.079	1.082	1.085	1.088	1.090
	1.2	1.082	1.080	1.076	1.074	1.072	1.069	1.067	1.065	1.067	1.070	1.073	1.076	1.080	1.083	1.086	1.089
	1.4	1.077	1.075	1.072	1.069	1.067	1.065	1.063	1.062	1.064	1.067	1.071	1.075	1.078	1.082	1.085	1.089
	1.6	1.074	1.073	1.069	1.067	1.065	1.063	1.061	1.060	1.063	1.067	1.071	1.075	1.079	1.082	1.086	1.090
	1.8	1.073	1.072	1.069	1.067	1.065	1.063	1.061	1.061	1.064	1.068	1.072	1.076	1.080	1.084	1.088	1.093
	2.0	1.074	1.073	1.070	1.068	1.066	1.064	1.063	1.063	1.066	1.070	1.075	1.079	1.083	1.088	1.092	1.096

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.327	0.458	0.677	0.786	0.863	0.963	1.021	1.099	1.103	1.093	1.082	1.073	1.066	1.061	1.057	1.054
	0.02	0.326	0.457	0.675	0.784	0.861	0.961	1.019	1.097	1.101	1.091	1.080	1.071	1.065	1.059	1.056	1.053
	0.05	0.324	0.454	0.671	0.779	0.856	0.955	1.014	1.092	1.096	1.087	1.076	1.068	1.061	1.056	1.053	1.050
	0.075	0.323	0.452	0.668	0.776	0.852	0.952	1.010	1.088	1.093	1.084	1.074	1.065	1.059	1.054	1.050	1.048
	0.1	0.321	0.450	0.666	0.773	0.849	0.948	1.006	1.085	1.090	1.081	1.071	1.063	1.057	1.052	1.049	1.047
	0.15	0.319	0.448	0.662	0.769	0.844	0.943	1.001	1.080	1.086	1.077	1.068	1.060	1.054	1.050	1.047	1.044
	0.2	0.318	0.445	0.658	0.765	0.840	0.939	0.997	1.077	1.083	1.075	1.066	1.058	1.052	1.048	1.045	1.043
	0.4	0.314	0.439	0.650	0.756	0.831	0.929	0.988	1.070	1.078	1.071	1.063	1.056	1.051	1.047	1.044	1.043
	0.6	0.311	0.436	0.646	0.751	0.826	0.924	0.983	1.068	1.077	1.072	1.065	1.058	1.053	1.050	1.047	1.046
	0.8	0.309	0.434	0.642	0.747	0.822	0.921	0.981	1.067	1.078	1.074	1.067	1.061	1.057	1.053	1.051	1.049
	1.0	0.308	0.432	0.640	0.745	0.820	0.919	0.979	1.067	1.080	1.077	1.071	1.065	1.060	1.057	1.055	1.054
	1.2	0.307	0.430	0.638	0.743	0.818	0.917	0.978	1.068	1.082	1.079	1.074	1.068	1.064	1.061	1.059	1.058
	1.4	0.306	0.429	0.637	0.741	0.816	0.916	0.977	1.069	1.084	1.082	1.077	1.072	1.068	1.065	1.063	1.062
	1.6	0.305	0.428	0.635	0.740	0.815	0.915	0.976	1.070	1.086	1.085	1.081	1.076	1.072	1.070	1.068	1.067
	1.8	0.305	0.428	0.635	0.739	0.814	0.915	0.976	1.071	1.088	1.088	1.084	1.080	1.077	1.074	1.072	1.072
	2.0	0.304	0.427	0.634	0.739	0.814	0.915	0.977	1.073	1.091	1.091	1.088	1.084	1.081	1.079	1.077	1.077

Table 10: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.40$ and $r/W = 0.10$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.344	0.343	0.341	0.340	0.338	0.337	0.335	0.332	0.331	0.331	0.332	0.332	0.333	0.334	0.335	0.336
	0.02	0.480	0.479	0.476	0.474	0.473	0.470	0.468	0.464	0.463	0.463	0.464	0.464	0.466	0.467	0.468	0.470
	0.05	0.709	0.708	0.704	0.701	0.698	0.695	0.692	0.687	0.686	0.686	0.687	0.688	0.690	0.692	0.695	0.697
	0.075	0.824	0.822	0.818	0.814	0.812	0.807	0.804	0.799	0.798	0.798	0.800	0.802	0.804	0.807	0.810	0.813
	0.1	0.905	0.903	0.898	0.895	0.892	0.887	0.884	0.878	0.877	0.879	0.881	0.883	0.886	0.889	0.892	0.896
	0.15	1.010	1.008	1.003	0.999	0.996	0.991	0.988	0.983	0.983	0.985	0.987	0.991	0.994	0.998	1.003	1.007
	0.2	1.073	1.071	1.065	1.062	1.059	1.054	1.050	1.046	1.047	1.049	1.053	1.057	1.062	1.067	1.072	1.077
	0.4	1.163	1.161	1.156	1.152	1.149	1.145	1.143	1.141	1.145	1.151	1.158	1.165	1.172	1.180	1.187	1.195
	0.6	1.178	1.176	1.171	1.168	1.166	1.162	1.160	1.161	1.168	1.177	1.186	1.195	1.205	1.214	1.224	1.233
	0.8	1.182	1.180	1.176	1.173	1.171	1.168	1.167	1.170	1.179	1.189	1.200	1.211	1.223	1.234	1.245	1.256
	1.0	1.188	1.186	1.182	1.180	1.178	1.175	1.175	1.180	1.190	1.202	1.215	1.228	1.241	1.254	1.266	1.279
	1.2	1.200	1.198	1.194	1.192	1.190	1.188	1.188	1.195	1.207	1.221	1.235	1.250	1.264	1.278	1.293	1.307
	1.4	1.219	1.217	1.213	1.211	1.210	1.208	1.208	1.216	1.230	1.246	1.262	1.278	1.294	1.310	1.327	1.343
	1.6	1.245	1.244	1.240	1.238	1.237	1.236	1.236	1.246	1.261	1.279	1.297	1.315	1.333	1.351	1.370	1.388
	1.8	1.282	1.281	1.277	1.275	1.274	1.273	1.274	1.285	1.303	1.322	1.342	1.363	1.383	1.404	1.424	1.445
	2.0	1.333	1.331	1.328	1.326	1.325	1.325	1.326	1.339	1.358	1.380	1.403	1.426	1.449	1.472	1.496	1.519

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.336	0.470	0.695	0.807	0.887	0.990	1.051	1.135	1.142	1.135	1.127	1.121	1.116	1.114	1.113	1.113
	0.02	0.336	0.469	0.693	0.806	0.885	0.988	1.049	1.133	1.140	1.133	1.125	1.119	1.115	1.112	1.111	1.111
	0.05	0.334	0.466	0.689	0.801	0.880	0.983	1.043	1.127	1.135	1.129	1.121	1.115	1.112	1.109	1.109	1.109
	0.075	0.332	0.464	0.687	0.798	0.877	0.979	1.040	1.124	1.132	1.126	1.119	1.113	1.110	1.108	1.107	1.107
	0.1	0.331	0.463	0.684	0.796	0.874	0.976	1.037	1.121	1.130	1.124	1.117	1.112	1.108	1.106	1.106	1.106
	0.15	0.330	0.460	0.681	0.792	0.870	0.972	1.032	1.118	1.127	1.122	1.115	1.110	1.107	1.105	1.105	1.105
	0.2	0.328	0.459	0.678	0.789	0.867	0.969	1.030	1.115	1.125	1.121	1.115	1.110	1.107	1.105	1.105	1.106
	0.4	0.326	0.455	0.674	0.784	0.863	0.965	1.027	1.116	1.128	1.125	1.120	1.116	1.114	1.113	1.113	1.115
	0.6	0.326	0.455	0.674	0.785	0.863	0.967	1.029	1.122	1.137	1.136	1.132	1.129	1.127	1.126	1.127	1.128
	0.8	0.326	0.456	0.676	0.787	0.867	0.971	1.035	1.131	1.148	1.148	1.146	1.143	1.142	1.142	1.143	1.145
	1.0	0.328	0.458	0.679	0.791	0.871	0.977	1.042	1.142	1.161	1.163	1.161	1.159	1.159	1.159	1.161	1.163
	1.2	0.330	0.461	0.684	0.797	0.878	0.985	1.051	1.154	1.176	1.179	1.178	1.177	1.177	1.178	1.180	1.183
	1.4	0.332	0.464	0.689	0.804	0.885	0.994	1.062	1.169	1.192	1.197	1.197	1.197	1.198	1.200	1.202	1.205
	1.6	0.335	0.469	0.696	0.812	0.895	1.006	1.075	1.185	1.211	1.217	1.219	1.220	1.221	1.224	1.227	1.230
	1.8	0.339	0.474	0.704	0.822	0.906	1.019	1.090	1.204	1.233	1.241	1.243	1.245	1.248	1.251	1.255	1.259
	2.0	0.344	0.481	0.715	0.834	0.920	1.035	1.108	1.227	1.258	1.268	1.272	1.275	1.279	1.283	1.287	1.292

Table 11: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.40$ and $r/W = 0.15$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.376	0.375	0.373	0.371	0.370	0.369	0.368	0.368	0.370	0.373	0.376	0.380	0.384	0.388	0.392	0.396
	0.02	0.525	0.524	0.521	0.519	0.517	0.515	0.514	0.514	0.517	0.521	0.526	0.531	0.537	0.542	0.548	0.554
	0.05	0.775	0.773	0.769	0.766	0.764	0.761	0.759	0.759	0.764	0.771	0.779	0.787	0.795	0.803	0.812	0.821
	0.075	0.900	0.898	0.893	0.890	0.887	0.884	0.882	0.883	0.889	0.897	0.906	0.916	0.926	0.936	0.946	0.957
	0.1	0.988	0.986	0.981	0.978	0.975	0.972	0.970	0.971	0.978	0.988	0.998	1.009	1.020	1.032	1.043	1.055
	0.15	1.106	1.103	1.098	1.094	1.091	1.088	1.086	1.088	1.097	1.109	1.122	1.135	1.148	1.162	1.175	1.189
	0.2	1.177	1.175	1.169	1.165	1.162	1.159	1.157	1.161	1.172	1.185	1.200	1.215	1.230	1.245	1.261	1.276
c_L/r	0.4	1.295	1.293	1.288	1.284	1.282	1.279	1.278	1.287	1.304	1.324	1.344	1.365	1.386	1.407	1.428	1.449
	0.6	1.341	1.339	1.334	1.331	1.329	1.327	1.327	1.341	1.363	1.388	1.414	1.440	1.466	1.492	1.518	1.544
	0.8	1.387	1.385	1.380	1.377	1.375	1.374	1.376	1.394	1.421	1.452	1.483	1.514	1.546	1.578	1.610	1.641
	1.0	1.454	1.452	1.447	1.445	1.444	1.443	1.446	1.469	1.502	1.538	1.576	1.614	1.653	1.691	1.730	1.769
	1.2	1.568	1.566	1.562	1.560	1.559	1.560	1.563	1.592	1.632	1.677	1.723	1.771	1.819	1.867	1.916	1.965
	1.4	1.813	1.811	1.806	1.804	1.803	1.805	1.810	1.849	1.901	1.960	2.021	2.084	2.149	2.215	2.281	2.348
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.350	0.490	0.724	0.841	0.924	1.033	1.098	1.190	1.202	1.199	1.195	1.192	1.191	1.191	1.192	1.195
	0.02	0.349	0.489	0.722	0.840	0.922	1.031	1.095	1.188	1.200	1.198	1.194	1.191	1.189	1.190	1.191	1.194
	0.05	0.348	0.486	0.719	0.835	0.918	1.026	1.090	1.183	1.196	1.194	1.190	1.188	1.187	1.187	1.189	1.191
	0.075	0.346	0.484	0.716	0.833	0.915	1.023	1.087	1.180	1.194	1.192	1.188	1.186	1.185	1.186	1.188	1.191
	0.1	0.346	0.483	0.715	0.831	0.913	1.021	1.085	1.179	1.192	1.191	1.188	1.186	1.185	1.186	1.188	1.191
	0.15	0.344	0.482	0.712	0.828	0.911	1.018	1.083	1.177	1.192	1.191	1.189	1.187	1.187	1.188	1.190	1.193
	0.2	0.344	0.481	0.712	0.828	0.910	1.018	1.083	1.178	1.194	1.194	1.192	1.190	1.191	1.192	1.194	1.198
c_L/r	0.4	0.346	0.484	0.716	0.833	0.917	1.027	1.094	1.195	1.214	1.217	1.216	1.216	1.218	1.220	1.223	1.227
	0.6	0.351	0.491	0.727	0.846	0.932	1.045	1.114	1.222	1.245	1.250	1.252	1.253	1.256	1.259	1.263	1.268
	0.8	0.357	0.500	0.741	0.864	0.951	1.068	1.140	1.255	1.283	1.291	1.295	1.298	1.302	1.307	1.312	1.318
	1.0	0.366	0.512	0.760	0.886	0.976	1.097	1.172	1.296	1.329	1.340	1.347	1.353	1.359	1.365	1.372	1.379
	1.2	0.377	0.528	0.784	0.915	1.009	1.135	1.214	1.348	1.386	1.402	1.412	1.421	1.430	1.439	1.448	1.457
	1.4	0.394	0.551	0.819	0.956	1.054	1.188	1.273	1.419	1.466	1.488	1.504	1.517	1.530	1.542	1.555	1.568
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 12: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.20$ and $r/W = 0.20$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.435	0.434	0.432	0.431	0.430	0.428	0.428	0.432	0.439	0.448	0.457	0.466	0.475	0.484	0.493	0.502
	0.02	0.606	0.605	0.602	0.600	0.599	0.597	0.597	0.603	0.613	0.625	0.637	0.650	0.662	0.675	0.688	0.700
	0.05	0.894	0.892	0.887	0.885	0.883	0.881	0.880	0.889	0.904	0.922	0.941	0.960	0.979	0.998	1.017	1.036
	0.075	1.038	1.036	1.031	1.028	1.026	1.023	1.023	1.034	1.053	1.074	1.096	1.119	1.141	1.164	1.186	1.209
	0.1	1.142	1.139	1.134	1.131	1.128	1.126	1.126	1.138	1.160	1.183	1.209	1.234	1.260	1.285	1.310	1.335
	0.15	1.282	1.279	1.273	1.270	1.267	1.265	1.266	1.281	1.306	1.335	1.365	1.395	1.425	1.455	1.485	1.515
	0.2	1.372	1.370	1.363	1.360	1.357	1.356	1.356	1.375	1.404	1.436	1.470	1.504	1.538	1.572	1.606	1.639
c_L/r	0.4	1.556	1.554	1.548	1.544	1.543	1.542	1.545	1.575	1.617	1.663	1.711	1.760	1.809	1.857	1.906	1.954
	0.6	1.692	1.689	1.683	1.681	1.680	1.681	1.686	1.728	1.784	1.847	1.911	1.977	2.044	2.110	2.177	2.243
	0.8	1.963	1.961	1.955	1.953	1.952	1.956	1.965	2.024	2.104	2.192	2.285	2.380	2.478	2.577	2.677	2.777
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.370	0.517	0.765	0.889	0.977	1.093	1.163	1.268	1.287	1.290	1.290	1.290	1.292	1.294	1.298	1.302
	0.02	0.369	0.516	0.763	0.887	0.976	1.091	1.161	1.266	1.285	1.288	1.288	1.289	1.290	1.293	1.297	1.301
	0.05	0.368	0.514	0.760	0.884	0.972	1.087	1.157	1.262	1.282	1.285	1.286	1.287	1.289	1.292	1.296	1.300
	0.075	0.367	0.513	0.758	0.882	0.970	1.085	1.155	1.261	1.281	1.285	1.286	1.287	1.290	1.293	1.297	1.301
	0.1	0.366	0.512	0.758	0.881	0.969	1.085	1.155	1.261	1.282	1.287	1.288	1.289	1.292	1.295	1.299	1.304
	0.15	0.367	0.513	0.759	0.882	0.971	1.087	1.157	1.265	1.288	1.293	1.295	1.297	1.300	1.304	1.308	1.313
	0.2	0.368	0.515	0.761	0.886	0.974	1.091	1.163	1.273	1.297	1.303	1.306	1.309	1.312	1.316	1.321	1.326
c_L/r	0.4	0.379	0.530	0.785	0.914	1.006	1.129	1.204	1.326	1.357	1.368	1.374	1.380	1.386	1.392	1.399	1.405
	0.6	0.396	0.554	0.821	0.957	1.055	1.185	1.267	1.403	1.443	1.461	1.473	1.483	1.493	1.503	1.513	1.522
	0.8	0.420	0.589	0.873	1.019	1.124	1.265	1.355	1.512	1.565	1.593	1.614	1.632	1.650	1.666	1.682	1.696
	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 13: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.50$ and $r/W = 0.05$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.326	0.325	0.323	0.322	0.321	0.319	0.317	0.313	0.310	0.308	0.306	0.305	0.304	0.303	0.302	0.301
	0.02	0.457	0.456	0.453	0.451	0.450	0.447	0.444	0.438	0.435	0.432	0.430	0.428	0.426	0.425	0.423	0.422
	0.05	0.675	0.674	0.670	0.667	0.664	0.660	0.657	0.648	0.643	0.640	0.637	0.634	0.632	0.630	0.628	0.626
	0.075	0.784	0.783	0.778	0.775	0.772	0.767	0.763	0.754	0.748	0.744	0.741	0.738	0.736	0.734	0.732	0.730
	0.1	0.861	0.859	0.854	0.851	0.848	0.842	0.838	0.828	0.823	0.819	0.815	0.812	0.810	0.808	0.806	0.804
	0.15	0.961	0.959	0.954	0.950	0.946	0.941	0.937	0.926	0.921	0.917	0.914	0.911	0.909	0.907	0.905	0.903
	0.2	1.019	1.017	1.012	1.008	1.005	0.999	0.995	0.985	0.979	0.976	0.973	0.971	0.969	0.967	0.966	0.964
	0.4	1.097	1.095	1.090	1.086	1.083	1.078	1.074	1.066	1.063	1.062	1.061	1.060	1.060	1.059	1.059	1.058
	0.6	1.101	1.099	1.094	1.091	1.088	1.083	1.080	1.075	1.073	1.073	1.074	1.074	1.075	1.075	1.076	1.076
	0.8	1.091	1.089	1.085	1.082	1.079	1.075	1.073	1.068	1.068	1.069	1.071	1.072	1.073	1.074	1.076	1.077
	1.0	1.081	1.079	1.075	1.072	1.070	1.066	1.064	1.061	1.061	1.063	1.065	1.067	1.069	1.070	1.072	1.074
	1.2	1.072	1.071	1.067	1.064	1.062	1.059	1.057	1.054	1.056	1.058	1.060	1.062	1.064	1.066	1.068	1.070
	1.4	1.066	1.065	1.061	1.059	1.057	1.054	1.052	1.050	1.051	1.054	1.056	1.059	1.061	1.064	1.066	1.068
	1.6	1.062	1.060	1.057	1.055	1.053	1.050	1.049	1.047	1.049	1.051	1.054	1.057	1.060	1.062	1.065	1.067
	1.8	1.059	1.058	1.055	1.053	1.051	1.049	1.047	1.046	1.048	1.050	1.053	1.056	1.059	1.062	1.065	1.067
	2.0	1.058	1.057	1.054	1.052	1.050	1.048	1.047	1.045	1.048	1.050	1.054	1.057	1.060	1.063	1.066	1.069

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.326	0.456	0.674	0.783	0.860	0.960	1.018	1.095	1.098	1.088	1.077	1.067	1.060	1.054	1.050	1.047
	0.02	0.325	0.455	0.673	0.781	0.858	0.958	1.016	1.093	1.097	1.086	1.075	1.066	1.058	1.053	1.049	1.046
	0.05	0.323	0.453	0.669	0.777	0.853	0.952	1.010	1.088	1.092	1.082	1.071	1.062	1.055	1.050	1.046	1.043
	0.075	0.322	0.451	0.666	0.774	0.849	0.948	1.006	1.084	1.088	1.079	1.068	1.059	1.053	1.047	1.044	1.041
	0.1	0.320	0.449	0.664	0.771	0.846	0.945	1.003	1.081	1.085	1.076	1.066	1.057	1.051	1.046	1.042	1.039
	0.15	0.318	0.446	0.659	0.766	0.841	0.940	0.998	1.076	1.081	1.072	1.063	1.054	1.048	1.043	1.039	1.037
	0.2	0.317	0.444	0.656	0.762	0.837	0.936	0.993	1.072	1.078	1.070	1.060	1.052	1.046	1.041	1.038	1.035
	0.4	0.312	0.438	0.648	0.753	0.827	0.925	0.983	1.065	1.072	1.065	1.057	1.050	1.044	1.039	1.036	1.034
	0.6	0.310	0.434	0.643	0.747	0.822	0.920	0.978	1.062	1.071	1.065	1.058	1.051	1.045	1.041	1.038	1.036
	0.8	0.308	0.431	0.639	0.743	0.818	0.916	0.975	1.060	1.071	1.066	1.059	1.053	1.047	1.044	1.041	1.039
	1.0	0.306	0.429	0.636	0.740	0.815	0.913	0.972	1.060	1.072	1.068	1.061	1.055	1.050	1.046	1.044	1.042
	1.2	0.305	0.427	0.634	0.738	0.812	0.911	0.970	1.059	1.073	1.070	1.063	1.058	1.053	1.049	1.046	1.045
	1.4	0.304	0.426	0.632	0.736	0.810	0.909	0.969	1.059	1.074	1.071	1.066	1.060	1.055	1.052	1.049	1.048
	1.6	0.303	0.425	0.630	0.734	0.808	0.907	0.967	1.059	1.075	1.073	1.068	1.062	1.058	1.055	1.052	1.051
	1.8	0.302	0.423	0.628	0.732	0.806	0.906	0.966	1.059	1.076	1.075	1.070	1.065	1.061	1.058	1.056	1.054
	2.0	0.301	0.423	0.627	0.731	0.805	0.905	0.966	1.060	1.077	1.077	1.072	1.068	1.064	1.061	1.059	1.057

***Table 14:** Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.50$ and $r/W = 0.10$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.337	0.336	0.334	0.333	0.331	0.329	0.328	0.324	0.323	0.322	0.322	0.321	0.321	0.321	0.322	0.322
	0.02	0.470	0.469	0.466	0.464	0.463	0.460	0.458	0.453	0.451	0.450	0.450	0.449	0.449	0.450	0.450	0.450
	0.05	0.695	0.693	0.689	0.687	0.684	0.680	0.677	0.671	0.668	0.667	0.666	0.666	0.666	0.667	0.668	0.668
	0.075	0.808	0.806	0.801	0.798	0.795	0.791	0.788	0.780	0.778	0.776	0.776	0.776	0.777	0.777	0.778	0.780
	0.1	0.887	0.885	0.880	0.877	0.874	0.869	0.865	0.858	0.855	0.854	0.854	0.855	0.855	0.856	0.858	0.859
	0.15	0.990	0.988	0.983	0.979	0.976	0.971	0.967	0.960	0.958	0.957	0.958	0.959	0.960	0.962	0.963	0.966
	0.2	1.051	1.049	1.043	1.040	1.036	1.031	1.028	1.021	1.019	1.020	1.021	1.023	1.025	1.027	1.029	1.032
	0.4	1.136	1.134	1.129	1.125	1.122	1.118	1.115	1.111	1.112	1.115	1.119	1.123	1.127	1.131	1.136	1.140
	0.6	1.146	1.144	1.139	1.136	1.133	1.130	1.127	1.126	1.129	1.135	1.140	1.146	1.152	1.158	1.163	1.169
	0.8	1.144	1.142	1.138	1.135	1.132	1.129	1.127	1.128	1.133	1.140	1.147	1.154	1.161	1.168	1.175	1.182
	1.0	1.143	1.141	1.137	1.134	1.132	1.129	1.128	1.130	1.136	1.144	1.152	1.160	1.169	1.177	1.185	1.193
	1.2	1.145	1.143	1.139	1.137	1.135	1.133	1.132	1.135	1.142	1.151	1.160	1.170	1.179	1.188	1.197	1.206
	1.4	1.151	1.150	1.146	1.144	1.142	1.140	1.139	1.143	1.152	1.162	1.172	1.182	1.193	1.203	1.213	1.223
	1.6	1.162	1.161	1.157	1.155	1.154	1.152	1.151	1.156	1.166	1.177	1.188	1.199	1.211	1.222	1.233	1.244
	1.8	1.178	1.176	1.173	1.171	1.170	1.168	1.168	1.174	1.184	1.196	1.209	1.221	1.234	1.246	1.258	1.270
	2.0	1.198	1.197	1.194	1.192	1.191	1.189	1.189	1.196	1.208	1.221	1.235	1.248	1.262	1.275	1.289	1.302

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.333	0.465	0.687	0.799	0.877	0.979	1.039	1.120	1.126	1.118	1.108	1.101	1.096	1.092	1.090	1.088
	0.02	0.332	0.464	0.686	0.797	0.875	0.977	1.037	1.118	1.124	1.116	1.107	1.100	1.094	1.091	1.088	1.087
	0.05	0.330	0.461	0.682	0.792	0.870	0.972	1.032	1.113	1.119	1.112	1.103	1.096	1.091	1.087	1.085	1.084
	0.075	0.328	0.459	0.679	0.789	0.867	0.968	1.028	1.109	1.116	1.109	1.100	1.093	1.089	1.085	1.084	1.083
	0.1	0.327	0.458	0.677	0.786	0.864	0.965	1.025	1.107	1.113	1.106	1.098	1.092	1.087	1.084	1.082	1.081
	0.15	0.325	0.455	0.673	0.782	0.859	0.960	1.020	1.102	1.110	1.103	1.096	1.089	1.085	1.082	1.081	1.080
	0.2	0.324	0.453	0.670	0.779	0.856	0.957	1.016	1.100	1.108	1.102	1.094	1.088	1.084	1.082	1.080	1.080
	0.4	0.321	0.449	0.664	0.773	0.850	0.950	1.010	1.096	1.107	1.103	1.096	1.091	1.088	1.085	1.084	1.084
	0.6	0.320	0.447	0.662	0.771	0.848	0.949	1.010	1.099	1.112	1.109	1.103	1.099	1.095	1.094	1.093	1.093
	0.8	0.319	0.447	0.662	0.771	0.848	0.950	1.012	1.104	1.118	1.116	1.112	1.108	1.105	1.104	1.103	1.103
	1.0	0.319	0.447	0.663	0.772	0.849	0.952	1.015	1.110	1.126	1.125	1.122	1.118	1.116	1.115	1.114	1.115
	1.2	0.320	0.448	0.664	0.774	0.852	0.956	1.019	1.117	1.134	1.135	1.132	1.129	1.127	1.126	1.126	1.127
	1.4	0.321	0.449	0.666	0.776	0.855	0.960	1.025	1.124	1.144	1.146	1.143	1.141	1.140	1.139	1.139	1.140
	1.6	0.322	0.451	0.669	0.780	0.860	0.966	1.031	1.133	1.155	1.157	1.156	1.154	1.153	1.153	1.154	1.155
	1.8	0.324	0.453	0.673	0.785	0.865	0.972	1.038	1.144	1.166	1.170	1.170	1.169	1.168	1.168	1.169	1.171
	2.0	0.326	0.456	0.678	0.791	0.872	0.980	1.047	1.155	1.180	1.185	1.185	1.185	1.185	1.185	1.187	1.189

Table 15: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.50$ and $r/W = 0.15$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.356	0.355	0.353	0.352	0.351	0.349	0.348	0.346	0.346	0.348	0.349	0.351	0.353	0.355	0.357	0.359
	0.02	0.498	0.496	0.494	0.492	0.490	0.488	0.486	0.484	0.484	0.486	0.488	0.491	0.494	0.497	0.500	0.503
	0.05	0.735	0.733	0.729	0.726	0.724	0.721	0.718	0.716	0.717	0.720	0.723	0.727	0.732	0.736	0.741	0.745
	0.075	0.854	0.852	0.847	0.844	0.841	0.838	0.835	0.832	0.834	0.838	0.842	0.847	0.852	0.858	0.863	0.869
	0.1	0.938	0.936	0.931	0.927	0.925	0.920	0.918	0.915	0.918	0.922	0.927	0.933	0.939	0.945	0.952	0.958
	0.15	1.048	1.046	1.040	1.037	1.034	1.029	1.027	1.025	1.028	1.034	1.041	1.048	1.055	1.063	1.071	1.078
	0.2	1.114	1.112	1.106	1.103	1.100	1.095	1.093	1.092	1.097	1.104	1.112	1.120	1.129	1.137	1.146	1.155
c_L/r	0.4	1.216	1.214	1.208	1.205	1.202	1.198	1.197	1.200	1.209	1.220	1.232	1.245	1.257	1.269	1.282	1.294
	0.6	1.243	1.241	1.236	1.233	1.231	1.228	1.227	1.233	1.246	1.261	1.276	1.292	1.307	1.323	1.338	1.353
	0.8	1.263	1.261	1.256	1.253	1.252	1.249	1.249	1.259	1.275	1.292	1.311	1.329	1.348	1.366	1.384	1.402
	1.0	1.290	1.288	1.284	1.281	1.279	1.278	1.279	1.291	1.310	1.331	1.352	1.374	1.395	1.417	1.438	1.459
	1.2	1.330	1.328	1.324	1.322	1.320	1.319	1.321	1.336	1.358	1.382	1.407	1.433	1.458	1.483	1.507	1.532
	1.4	1.388	1.386	1.382	1.380	1.379	1.379	1.380	1.399	1.425	1.453	1.483	1.512	1.542	1.571	1.600	1.629
	1.6	1.472	1.470	1.467	1.465	1.464	1.464	1.467	1.489	1.520	1.553	1.588	1.623	1.658	1.693	1.728	1.763
	1.8	1.603	1.602	1.598	1.596	1.596	1.597	1.600	1.627	1.665	1.705	1.748	1.791	1.834	1.877	1.921	1.964
	2.0	1.847	1.845	1.841	1.839	1.839	1.841	1.846	1.881	1.929	1.982	2.037	2.093	2.150	2.207	2.265	2.323

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.343	0.479	0.708	0.823	0.904	1.009	1.072	1.159	1.168	1.163	1.156	1.151	1.147	1.146	1.145	1.146
	0.02	0.342	0.478	0.707	0.821	0.902	1.007	1.070	1.157	1.166	1.161	1.154	1.149	1.146	1.145	1.144	1.145
	0.05	0.340	0.475	0.703	0.817	0.897	1.002	1.065	1.152	1.162	1.157	1.151	1.146	1.143	1.142	1.141	1.142
	0.075	0.339	0.474	0.700	0.814	0.894	0.999	1.061	1.149	1.159	1.154	1.148	1.144	1.141	1.140	1.140	1.141
	0.1	0.338	0.472	0.698	0.811	0.892	0.996	1.058	1.147	1.157	1.153	1.147	1.143	1.140	1.139	1.139	1.141
	0.15	0.336	0.470	0.695	0.808	0.888	0.993	1.055	1.144	1.155	1.151	1.146	1.142	1.140	1.139	1.140	1.141
	0.2	0.335	0.469	0.693	0.806	0.886	0.991	1.053	1.143	1.155	1.152	1.147	1.143	1.141	1.141	1.141	1.143
c_L/r	0.4	0.334	0.468	0.693	0.806	0.886	0.992	1.055	1.149	1.164	1.163	1.160	1.157	1.156	1.156	1.157	1.158
	0.6	0.336	0.470	0.697	0.811	0.892	1.000	1.065	1.163	1.181	1.182	1.180	1.178	1.177	1.178	1.179	1.181
	0.8	0.339	0.475	0.704	0.819	0.902	1.012	1.079	1.182	1.202	1.205	1.204	1.203	1.203	1.204	1.206	1.209
	1.0	0.343	0.481	0.713	0.830	0.914	1.026	1.095	1.204	1.227	1.232	1.232	1.233	1.233	1.235	1.238	1.241
	1.2	0.349	0.488	0.724	0.844	0.930	1.045	1.116	1.229	1.256	1.263	1.265	1.267	1.268	1.271	1.274	1.278
	1.4	0.355	0.497	0.738	0.861	0.949	1.067	1.141	1.260	1.291	1.300	1.304	1.307	1.310	1.314	1.318	1.322
	1.6	0.364	0.510	0.757	0.883	0.973	1.095	1.172	1.299	1.333	1.345	1.351	1.356	1.361	1.366	1.371	1.376
	1.8	0.375	0.525	0.780	0.911	1.005	1.132	1.212	1.348	1.387	1.403	1.412	1.419	1.425	1.432	1.439	1.446
	2.0	0.391	0.548	0.814	0.951	1.050	1.183	1.268	1.416	1.462	1.483	1.496	1.506	1.516	1.525	1.534	1.543

Table 16: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.50$ and $r/W = 0.20$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.389	0.388	0.386	0.385	0.384	0.383	0.382	0.383	0.386	0.390	0.395	0.399	0.404	0.409	0.414	0.418
	0.02	0.544	0.543	0.540	0.538	0.537	0.535	0.534	0.535	0.540	0.546	0.552	0.559	0.565	0.572	0.579	0.585
	0.05	0.803	0.801	0.797	0.794	0.792	0.789	0.788	0.790	0.798	0.807	0.817	0.827	0.837	0.847	0.857	0.867
	0.075	0.932	0.931	0.926	0.923	0.920	0.917	0.916	0.919	0.928	0.939	0.951	0.963	0.975	0.987	0.999	1.011
	0.1	1.025	1.023	1.018	1.014	1.012	1.008	1.007	1.011	1.022	1.034	1.048	1.062	1.075	1.089	1.103	1.116
	0.15	1.148	1.145	1.140	1.136	1.134	1.130	1.129	1.135	1.148	1.163	1.179	1.196	1.212	1.228	1.244	1.260
	0.2	1.224	1.222	1.216	1.212	1.210	1.207	1.206	1.213	1.228	1.246	1.264	1.283	1.301	1.320	1.338	1.356
c_L/r	0.4	1.361	1.358	1.353	1.349	1.347	1.345	1.345	1.359	1.382	1.407	1.433	1.459	1.485	1.510	1.535	1.560
	0.6	1.430	1.427	1.422	1.419	1.417	1.416	1.418	1.438	1.468	1.501	1.534	1.567	1.600	1.632	1.664	1.695
	0.8	1.509	1.507	1.502	1.499	1.498	1.498	1.501	1.528	1.566	1.607	1.648	1.690	1.732	1.772	1.813	1.852
	1.0	1.632	1.629	1.625	1.623	1.622	1.623	1.628	1.663	1.711	1.763	1.816	1.869	1.923	1.975	2.027	2.079
	1.2	1.867	1.865	1.860	1.858	1.858	1.861	1.868	1.916	1.979	2.049	2.121	2.194	2.267	2.341	2.413	2.485
	1.4	2.666	2.663	2.657	2.656	2.656	2.664	2.676	2.760	2.871	2.993	3.122	3.255	3.390	3.527	3.665	3.802
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.356	0.498	0.736	0.856	0.941	1.051	1.117	1.212	1.225	1.223	1.219	1.216	1.215	1.215	1.216	1.219
	0.02	0.356	0.497	0.735	0.854	0.939	1.049	1.115	1.210	1.223	1.221	1.217	1.214	1.213	1.214	1.215	1.218
	0.05	0.354	0.495	0.731	0.850	0.934	1.044	1.110	1.205	1.219	1.218	1.214	1.212	1.211	1.211	1.213	1.216
	0.075	0.353	0.493	0.729	0.848	0.932	1.041	1.107	1.203	1.217	1.216	1.213	1.210	1.210	1.210	1.212	1.215
	0.1	0.352	0.492	0.728	0.846	0.930	1.040	1.105	1.202	1.217	1.216	1.213	1.211	1.210	1.211	1.213	1.216
	0.15	0.351	0.491	0.726	0.844	0.928	1.038	1.104	1.202	1.217	1.217	1.215	1.213	1.213	1.214	1.216	1.219
	0.2	0.351	0.491	0.726	0.845	0.929	1.039	1.105	1.204	1.221	1.221	1.219	1.218	1.218	1.219	1.222	1.225
c_L/r	0.4	0.355	0.497	0.735	0.855	0.941	1.054	1.123	1.228	1.249	1.253	1.252	1.252	1.253	1.255	1.258	1.262
	0.6	0.363	0.508	0.752	0.876	0.964	1.081	1.153	1.266	1.292	1.298	1.300	1.302	1.304	1.307	1.310	1.314
	0.8	0.373	0.523	0.775	0.903	0.994	1.117	1.193	1.315	1.346	1.356	1.361	1.365	1.368	1.372	1.377	1.381
	1.0	0.388	0.543	0.805	0.939	1.035	1.163	1.244	1.378	1.416	1.431	1.439	1.446	1.452	1.458	1.463	1.469
	1.2	0.408	0.571	0.848	0.989	1.091	1.228	1.315	1.466	1.513	1.534	1.548	1.559	1.569	1.578	1.587	1.595
	1.4	0.445	0.623	0.926	1.082	1.194	1.347	1.446	1.623	1.688	1.722	1.747	1.768	1.787	1.804	1.820	1.834
	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 17: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.60$ and $r/W = 0.05$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.325	0.325	0.323	0.321	0.320	0.318	0.316	0.312	0.309	0.307	0.305	0.304	0.302	0.301	0.300	0.299
	0.02	0.456	0.455	0.452	0.450	0.448	0.445	0.443	0.437	0.433	0.430	0.428	0.426	0.424	0.422	0.421	0.419
	0.05	0.674	0.672	0.668	0.665	0.663	0.659	0.655	0.646	0.641	0.637	0.634	0.631	0.629	0.626	0.624	0.622
	0.075	0.782	0.781	0.776	0.773	0.770	0.765	0.761	0.751	0.746	0.741	0.738	0.735	0.732	0.730	0.727	0.725
	0.1	0.859	0.857	0.852	0.849	0.845	0.840	0.836	0.826	0.820	0.816	0.812	0.809	0.806	0.804	0.801	0.799
	0.15	0.959	0.957	0.951	0.947	0.944	0.939	0.934	0.924	0.918	0.913	0.910	0.907	0.904	0.902	0.900	0.898
	0.2	1.017	1.015	1.009	1.005	1.002	0.996	0.992	0.982	0.976	0.972	0.969	0.967	0.964	0.962	0.960	0.958
c_L/r	0.4	1.094	1.092	1.087	1.083	1.080	1.075	1.071	1.063	1.059	1.057	1.056	1.055	1.054	1.053	1.052	1.051
	0.6	1.097	1.095	1.090	1.087	1.084	1.080	1.077	1.070	1.069	1.068	1.068	1.068	1.068	1.068	1.068	1.068
	0.8	1.087	1.085	1.081	1.078	1.075	1.071	1.069	1.064	1.063	1.064	1.064	1.065	1.066	1.067	1.067	1.068
	1.0	1.076	1.074	1.070	1.068	1.065	1.062	1.059	1.056	1.056	1.057	1.058	1.059	1.061	1.062	1.063	1.064
	1.2	1.067	1.065	1.062	1.059	1.057	1.054	1.052	1.049	1.049	1.050	1.052	1.054	1.055	1.057	1.058	1.060
	1.4	1.060	1.059	1.055	1.053	1.051	1.048	1.046	1.043	1.044	1.046	1.048	1.050	1.051	1.053	1.055	1.056
	1.6	1.055	1.054	1.050	1.048	1.046	1.044	1.042	1.040	1.041	1.043	1.045	1.047	1.049	1.051	1.053	1.054
	1.8	1.051	1.050	1.047	1.045	1.043	1.041	1.039	1.037	1.038	1.040	1.043	1.045	1.047	1.049	1.051	1.053
	2.0	1.049	1.048	1.045	1.043	1.041	1.039	1.038	1.036	1.037	1.039	1.042	1.044	1.046	1.049	1.051	1.053

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.326	0.455	0.673	0.782	0.858	0.958	1.016	1.093	1.096	1.085	1.074	1.064	1.056	1.050	1.046	1.042
	0.02	0.325	0.454	0.671	0.780	0.857	0.956	1.014	1.091	1.094	1.083	1.072	1.062	1.055	1.049	1.044	1.041
	0.05	0.323	0.451	0.667	0.775	0.852	0.950	1.008	1.086	1.089	1.079	1.068	1.059	1.051	1.046	1.041	1.038
	0.075	0.322	0.449	0.664	0.772	0.848	0.946	1.004	1.082	1.086	1.076	1.065	1.056	1.049	1.043	1.039	1.036
	0.1	0.320	0.448	0.662	0.769	0.845	0.943	1.001	1.079	1.083	1.073	1.063	1.054	1.047	1.042	1.038	1.035
	0.15	0.318	0.445	0.658	0.765	0.840	0.938	0.995	1.074	1.078	1.069	1.059	1.051	1.044	1.039	1.035	1.032
	0.2	0.317	0.442	0.654	0.761	0.836	0.933	0.991	1.070	1.075	1.067	1.057	1.049	1.042	1.037	1.033	1.031
c_L/r	0.4	0.312	0.436	0.646	0.751	0.826	0.923	0.981	1.062	1.069	1.062	1.053	1.045	1.039	1.035	1.031	1.029
	0.6	0.309	0.432	0.640	0.745	0.820	0.917	0.975	1.058	1.067	1.061	1.053	1.046	1.040	1.036	1.032	1.030
	0.8	0.307	0.430	0.636	0.741	0.815	0.913	0.972	1.057	1.067	1.062	1.054	1.047	1.042	1.038	1.034	1.032
	1.0	0.306	0.427	0.633	0.738	0.812	0.910	0.969	1.055	1.067	1.063	1.056	1.049	1.044	1.040	1.037	1.034
	1.2	0.304	0.425	0.631	0.735	0.809	0.907	0.966	1.054	1.067	1.064	1.057	1.051	1.046	1.042	1.039	1.037
	1.4	0.303	0.424	0.628	0.732	0.806	0.904	0.964	1.054	1.067	1.065	1.059	1.053	1.048	1.044	1.041	1.039
	1.6	0.302	0.422	0.626	0.730	0.804	0.902	0.962	1.053	1.068	1.066	1.060	1.054	1.050	1.046	1.043	1.041
	1.8	0.301	0.421	0.624	0.728	0.802	0.900	0.960	1.052	1.068	1.067	1.061	1.056	1.052	1.048	1.045	1.043
	2.0	0.300	0.419	0.623	0.726	0.800	0.898	0.959	1.052	1.069	1.068	1.063	1.058	1.054	1.050	1.048	1.046

Table 18: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.60$ and $r/W = 0.10$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.333	0.332	0.330	0.329	0.328	0.326	0.324	0.320	0.318	0.317	0.316	0.315	0.315	0.315	0.314	0.314
	0.02	0.465	0.464	0.461	0.459	0.458	0.455	0.453	0.447	0.445	0.443	0.442	0.441	0.440	0.440	0.440	0.439
	0.05	0.687	0.686	0.682	0.679	0.676	0.672	0.669	0.662	0.659	0.656	0.655	0.654	0.653	0.653	0.652	0.652
	0.075	0.799	0.797	0.792	0.789	0.786	0.782	0.778	0.770	0.766	0.764	0.763	0.762	0.761	0.761	0.761	0.761
	0.1	0.877	0.875	0.870	0.867	0.864	0.859	0.855	0.847	0.843	0.841	0.840	0.839	0.838	0.838	0.838	0.838
	0.15	0.979	0.977	0.971	0.968	0.964	0.959	0.955	0.947	0.943	0.942	0.941	0.941	0.941	0.941	0.941	0.942
	0.2	1.039	1.037	1.031	1.027	1.024	1.019	1.015	1.007	1.004	1.003	1.003	1.003	1.003	1.004	1.005	1.006
c_L/r	0.4	1.121	1.119	1.114	1.110	1.107	1.102	1.099	1.094	1.093	1.095	1.097	1.099	1.101	1.104	1.106	1.109
	0.6	1.129	1.127	1.122	1.118	1.116	1.112	1.109	1.106	1.108	1.111	1.114	1.118	1.122	1.126	1.129	1.133
	0.8	1.123	1.122	1.117	1.114	1.112	1.108	1.106	1.105	1.108	1.112	1.117	1.122	1.127	1.131	1.136	1.141
	1.0	1.118	1.116	1.112	1.110	1.107	1.104	1.103	1.102	1.107	1.112	1.118	1.123	1.129	1.135	1.140	1.146
	1.2	1.116	1.114	1.110	1.108	1.106	1.103	1.102	1.102	1.107	1.114	1.120	1.127	1.133	1.139	1.145	1.151
	1.4	1.116	1.115	1.111	1.109	1.107	1.105	1.104	1.105	1.111	1.118	1.125	1.132	1.139	1.146	1.153	1.160
	1.6	1.120	1.119	1.116	1.114	1.112	1.110	1.109	1.111	1.118	1.125	1.133	1.141	1.148	1.156	1.163	1.171
	1.8	1.128	1.126	1.123	1.121	1.120	1.118	1.117	1.120	1.127	1.135	1.143	1.152	1.160	1.168	1.177	1.185
	2.0	1.138	1.136	1.133	1.131	1.130	1.128	1.128	1.131	1.139	1.148	1.157	1.166	1.175	1.184	1.193	1.202

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.330	0.462	0.683	0.793	0.871	0.972	1.032	1.112	1.116	1.107	1.097	1.089	1.083	1.078	1.076	1.074
	0.02	0.330	0.461	0.681	0.792	0.869	0.970	1.030	1.110	1.114	1.105	1.096	1.087	1.081	1.077	1.074	1.073
	0.05	0.328	0.458	0.677	0.787	0.864	0.965	1.024	1.104	1.109	1.101	1.091	1.084	1.078	1.074	1.071	1.070
	0.075	0.326	0.456	0.675	0.784	0.861	0.961	1.020	1.101	1.106	1.098	1.089	1.081	1.076	1.072	1.069	1.068
	0.1	0.325	0.455	0.672	0.781	0.858	0.958	1.017	1.098	1.103	1.096	1.087	1.079	1.074	1.070	1.068	1.066
	0.15	0.323	0.452	0.668	0.777	0.853	0.953	1.012	1.093	1.100	1.092	1.084	1.077	1.072	1.068	1.066	1.065
	0.2	0.322	0.450	0.665	0.773	0.850	0.949	1.008	1.090	1.097	1.090	1.082	1.075	1.070	1.067	1.065	1.064
c_L/r	0.4	0.318	0.445	0.658	0.766	0.842	0.941	1.001	1.085	1.094	1.089	1.082	1.076	1.072	1.069	1.067	1.066
	0.6	0.316	0.442	0.655	0.762	0.838	0.938	0.999	1.085	1.097	1.093	1.086	1.081	1.077	1.074	1.073	1.072
	0.8	0.315	0.441	0.653	0.761	0.837	0.938	0.998	1.088	1.101	1.098	1.092	1.087	1.084	1.081	1.080	1.079
	1.0	0.315	0.440	0.653	0.760	0.837	0.938	0.999	1.091	1.106	1.104	1.099	1.094	1.091	1.089	1.087	1.087
	1.2	0.314	0.440	0.653	0.760	0.837	0.939	1.001	1.095	1.111	1.110	1.106	1.102	1.099	1.097	1.096	1.096
	1.4	0.314	0.440	0.653	0.761	0.838	0.941	1.003	1.099	1.117	1.117	1.113	1.110	1.107	1.105	1.104	1.104
	1.6	0.315	0.441	0.654	0.762	0.840	0.943	1.007	1.105	1.123	1.124	1.121	1.118	1.116	1.114	1.114	1.114
	1.8	0.315	0.442	0.656	0.764	0.843	0.946	1.010	1.111	1.131	1.132	1.130	1.127	1.125	1.124	1.124	1.124
	2.0	0.316	0.443	0.658	0.767	0.846	0.950	1.015	1.117	1.139	1.141	1.140	1.137	1.136	1.135	1.135	1.135

Table 19: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.40$ and $r/W = 0.15$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.346	0.345	0.343	0.342	0.341	0.339	0.337	0.335	0.334	0.334	0.335	0.335	0.336	0.337	0.338	0.339
	0.02	0.483	0.482	0.480	0.478	0.476	0.473	0.472	0.468	0.467	0.468	0.468	0.469	0.471	0.472	0.474	0.475
	0.05	0.714	0.713	0.709	0.706	0.703	0.700	0.697	0.692	0.692	0.692	0.694	0.696	0.698	0.700	0.702	0.705
	0.075	0.830	0.828	0.823	0.820	0.817	0.813	0.810	0.805	0.805	0.806	0.808	0.810	0.813	0.816	0.819	0.822
	0.1	0.911	0.909	0.904	0.901	0.898	0.894	0.891	0.885	0.885	0.887	0.889	0.892	0.895	0.899	0.902	0.906
	0.15	1.018	1.016	1.010	1.007	1.004	0.999	0.996	0.991	0.992	0.994	0.998	1.002	1.006	1.010	1.014	1.019
	0.2	1.082	1.079	1.074	1.070	1.067	1.062	1.059	1.055	1.057	1.060	1.065	1.069	1.074	1.079	1.085	1.090
	0.4	1.175	1.172	1.167	1.163	1.160	1.156	1.154	1.153	1.159	1.166	1.173	1.181	1.189	1.197	1.204	1.212
	0.6	1.193	1.191	1.186	1.182	1.180	1.177	1.175	1.177	1.185	1.195	1.205	1.215	1.225	1.235	1.245	1.254
	0.8	1.200	1.198	1.194	1.191	1.189	1.186	1.185	1.190	1.200	1.211	1.224	1.236	1.248	1.259	1.271	1.283
	1.0	1.211	1.209	1.205	1.202	1.201	1.198	1.198	1.205	1.217	1.230	1.244	1.258	1.272	1.286	1.299	1.312
	1.2	1.229	1.227	1.223	1.221	1.219	1.218	1.218	1.226	1.240	1.256	1.272	1.288	1.304	1.319	1.334	1.349
	1.4	1.256	1.254	1.251	1.249	1.247	1.246	1.246	1.257	1.273	1.291	1.309	1.327	1.345	1.362	1.379	1.396
	1.6	1.294	1.292	1.289	1.287	1.286	1.285	1.286	1.298	1.316	1.336	1.357	1.378	1.398	1.418	1.438	1.457
	1.8	1.345	1.343	1.340	1.338	1.337	1.337	1.338	1.353	1.374	1.397	1.420	1.444	1.467	1.490	1.513	1.535
	2.0	1.414	1.413	1.409	1.408	1.407	1.407	1.409	1.426	1.450	1.477	1.504	1.531	1.558	1.585	1.611	1.637

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.338	0.473	0.698	0.812	0.891	0.995	1.056	1.141	1.148	1.141	1.133	1.126	1.122	1.119	1.118	1.119
	0.02	0.337	0.472	0.697	0.810	0.889	0.993	1.054	1.138	1.146	1.139	1.131	1.125	1.121	1.118	1.117	1.117
	0.05	0.335	0.469	0.693	0.805	0.885	0.988	1.049	1.133	1.141	1.135	1.127	1.121	1.117	1.115	1.114	1.115
	0.075	0.334	0.467	0.690	0.802	0.881	0.984	1.045	1.130	1.138	1.132	1.125	1.119	1.115	1.113	1.113	1.113
	0.1	0.333	0.465	0.688	0.800	0.879	0.981	1.042	1.127	1.136	1.130	1.123	1.117	1.114	1.112	1.112	1.112
	0.15	0.331	0.463	0.685	0.796	0.875	0.977	1.038	1.124	1.133	1.128	1.121	1.116	1.113	1.111	1.111	1.111
	0.2	0.330	0.461	0.682	0.793	0.872	0.974	1.035	1.122	1.132	1.127	1.121	1.116	1.113	1.111	1.111	1.112
	0.4	0.328	0.459	0.679	0.790	0.868	0.971	1.033	1.123	1.135	1.132	1.127	1.123	1.121	1.120	1.120	1.121
	0.6	0.328	0.459	0.680	0.791	0.870	0.975	1.038	1.131	1.146	1.144	1.140	1.137	1.135	1.134	1.135	1.136
	0.8	0.329	0.461	0.683	0.795	0.875	0.981	1.045	1.142	1.159	1.159	1.156	1.153	1.151	1.151	1.152	1.153
	1.0	0.331	0.464	0.687	0.801	0.881	0.989	1.054	1.155	1.174	1.175	1.173	1.171	1.170	1.170	1.171	1.173
	1.2	0.334	0.467	0.693	0.808	0.890	0.999	1.066	1.170	1.191	1.194	1.193	1.192	1.191	1.192	1.193	1.195
	1.4	0.337	0.472	0.701	0.817	0.900	1.011	1.079	1.188	1.211	1.216	1.216	1.215	1.215	1.216	1.217	1.219
	1.6	0.342	0.478	0.710	0.828	0.912	1.025	1.096	1.208	1.235	1.240	1.241	1.242	1.242	1.244	1.246	1.248
	1.8	0.347	0.486	0.722	0.842	0.928	1.044	1.116	1.233	1.262	1.270	1.272	1.273	1.274	1.276	1.279	1.281
	2.0	0.354	0.496	0.736	0.859	0.947	1.066	1.140	1.263	1.295	1.305	1.308	1.310	1.313	1.315	1.318	1.321

Table 20: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.60$ and $r/W = 0.20$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.367	0.366	0.364	0.363	0.362	0.360	0.359	0.358	0.360	0.362	0.364	0.367	0.370	0.372	0.375	0.378
	0.02	0.513	0.512	0.509	0.507	0.506	0.504	0.502	0.501	0.503	0.506	0.510	0.514	0.517	0.521	0.525	0.529
	0.05	0.758	0.756	0.752	0.750	0.747	0.744	0.742	0.741	0.744	0.749	0.755	0.761	0.766	0.772	0.778	0.785
	0.075	0.881	0.879	0.874	0.871	0.868	0.865	0.863	0.862	0.866	0.872	0.879	0.886	0.893	0.900	0.907	0.915
	0.1	0.968	0.966	0.961	0.957	0.955	0.951	0.949	0.948	0.953	0.960	0.968	0.976	0.984	0.992	1.001	1.009
	0.15	1.082	1.080	1.075	1.071	1.068	1.064	1.062	1.062	1.069	1.078	1.088	1.097	1.107	1.117	1.127	1.137
	0.2	1.152	1.150	1.144	1.140	1.138	1.134	1.132	1.133	1.142	1.152	1.163	1.174	1.186	1.197	1.208	1.219
	0.4	1.266	1.263	1.258	1.254	1.252	1.249	1.248	1.254	1.268	1.283	1.300	1.316	1.331	1.347	1.362	1.377
	0.6	1.307	1.305	1.300	1.297	1.295	1.292	1.292	1.303	1.321	1.341	1.362	1.382	1.402	1.421	1.440	1.458
	0.8	1.346	1.344	1.339	1.336	1.334	1.333	1.334	1.349	1.371	1.396	1.420	1.445	1.469	1.492	1.515	1.537
	1.0	1.400	1.398	1.394	1.391	1.390	1.389	1.391	1.410	1.437	1.467	1.496	1.525	1.554	1.582	1.610	1.636
	1.2	1.481	1.479	1.475	1.473	1.472	1.472	1.475	1.499	1.532	1.567	1.603	1.639	1.673	1.708	1.741	1.773
	1.4	1.605	1.604	1.599	1.598	1.597	1.598	1.602	1.633	1.673	1.717	1.761	1.805	1.849	1.892	1.933	1.974
	1.6	1.815	1.813	1.809	1.808	1.807	1.810	1.816	1.855	1.908	1.964	2.022	2.080	2.138	2.194	2.250	2.304
	1.8	2.297	2.295	2.290	2.289	2.289	2.294	2.303	2.363	2.441	2.525	2.613	2.701	2.789	2.877	2.963	3.048
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.348	0.487	0.720	0.836	0.919	1.026	1.090	1.179	1.190	1.185	1.179	1.175	1.173	1.173	1.174	1.178
	0.02	0.348	0.486	0.718	0.835	0.917	1.024	1.088	1.177	1.188	1.183	1.178	1.173	1.171	1.171	1.173	1.177
	0.05	0.346	0.483	0.714	0.830	0.912	1.019	1.083	1.172	1.183	1.179	1.174	1.170	1.168	1.169	1.171	1.174
	0.075	0.344	0.482	0.712	0.827	0.909	1.016	1.079	1.169	1.181	1.177	1.172	1.168	1.167	1.167	1.169	1.173
	0.1	0.344	0.480	0.710	0.825	0.907	1.013	1.077	1.167	1.179	1.176	1.171	1.168	1.166	1.167	1.169	1.173
	0.15	0.342	0.479	0.708	0.823	0.904	1.010	1.074	1.166	1.178	1.175	1.171	1.168	1.167	1.167	1.170	1.174
	0.2	0.342	0.478	0.706	0.821	0.903	1.009	1.073	1.166	1.179	1.177	1.173	1.170	1.169	1.170	1.172	1.176
	0.4	0.342	0.479	0.709	0.825	0.907	1.015	1.080	1.178	1.194	1.194	1.191	1.189	1.189	1.190	1.193	1.197
	0.6	0.346	0.484	0.717	0.835	0.918	1.029	1.097	1.199	1.219	1.221	1.219	1.218	1.218	1.220	1.223	1.227
	0.8	0.352	0.492	0.729	0.849	0.935	1.048	1.118	1.227	1.250	1.253	1.253	1.253	1.254	1.256	1.259	1.263
	1.0	0.359	0.502	0.744	0.867	0.955	1.073	1.145	1.260	1.287	1.293	1.294	1.295	1.297	1.299	1.302	1.306
	1.2	0.368	0.515	0.765	0.891	0.982	1.104	1.179	1.302	1.333	1.342	1.345	1.347	1.350	1.352	1.356	1.360
	1.4	0.381	0.533	0.791	0.922	1.017	1.144	1.224	1.356	1.392	1.404	1.410	1.414	1.417	1.421	1.425	1.430
	1.6	0.398	0.558	0.828	0.966	1.066	1.200	1.285	1.430	1.472	1.489	1.498	1.505	1.510	1.516	1.521	1.526
	1.8	0.426	0.597	0.887	1.036	1.144	1.290	1.383	1.547	1.600	1.625	1.640	1.651	1.661	1.669	1.677	1.684
	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 21: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.70$ and $r/W = 0.05$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.326	0.325	0.323	0.321	0.320	0.318	0.316	0.312	0.309	0.307	0.305	0.303	0.302	0.301	0.299	0.298
	0.02	0.455	0.454	0.451	0.449	0.447	0.444	0.442	0.436	0.432	0.429	0.426	0.424	0.422	0.420	0.419	0.417
	0.05	0.672	0.671	0.667	0.664	0.661	0.657	0.654	0.645	0.639	0.635	0.632	0.629	0.626	0.624	0.622	0.620
	0.075	0.781	0.779	0.775	0.772	0.769	0.764	0.760	0.750	0.744	0.740	0.736	0.733	0.730	0.727	0.725	0.723
	0.1	0.858	0.856	0.851	0.847	0.844	0.839	0.835	0.825	0.818	0.814	0.810	0.807	0.804	0.801	0.799	0.796
	0.15	0.957	0.955	0.950	0.946	0.942	0.937	0.933	0.922	0.916	0.911	0.908	0.904	0.901	0.899	0.896	0.894
	0.2	1.015	1.013	1.008	1.004	1.000	0.995	0.990	0.980	0.974	0.970	0.967	0.964	0.961	0.959	0.956	0.954
c_L/r	0.4	1.092	1.090	1.085	1.081	1.078	1.073	1.069	1.061	1.057	1.055	1.053	1.052	1.050	1.049	1.048	1.047
	0.6	1.095	1.093	1.088	1.085	1.082	1.077	1.074	1.068	1.066	1.065	1.065	1.064	1.064	1.064	1.063	1.063
	0.8	1.084	1.083	1.078	1.075	1.073	1.069	1.066	1.061	1.060	1.060	1.060	1.061	1.061	1.062	1.062	1.062
	1.0	1.073	1.072	1.067	1.065	1.062	1.059	1.056	1.052	1.052	1.053	1.054	1.055	1.055	1.056	1.057	1.058
	1.2	1.064	1.062	1.058	1.056	1.054	1.050	1.048	1.045	1.045	1.046	1.047	1.049	1.050	1.051	1.052	1.053
	1.4	1.056	1.055	1.051	1.049	1.047	1.044	1.042	1.039	1.039	1.041	1.042	1.044	1.045	1.047	1.048	1.049
	1.6	1.051	1.049	1.046	1.044	1.042	1.039	1.037	1.035	1.035	1.037	1.039	1.040	1.042	1.043	1.045	1.046
	1.8	1.047	1.045	1.042	1.040	1.038	1.036	1.034	1.032	1.033	1.034	1.036	1.038	1.040	1.041	1.043	1.044
	2.0	1.044	1.043	1.040	1.038	1.036	1.034	1.032	1.030	1.031	1.033	1.035	1.036	1.038	1.040	1.042	1.043

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.326	0.455	0.672	0.781	0.857	0.957	1.015	1.092	1.094	1.083	1.072	1.062	1.054	1.048	1.043	1.039
	0.02	0.325	0.454	0.670	0.779	0.855	0.954	1.013	1.090	1.092	1.081	1.070	1.060	1.052	1.046	1.042	1.038
	0.05	0.323	0.451	0.666	0.774	0.851	0.949	1.007	1.084	1.087	1.077	1.066	1.056	1.049	1.043	1.039	1.035
	0.075	0.321	0.449	0.664	0.771	0.847	0.945	1.003	1.080	1.084	1.074	1.063	1.054	1.046	1.041	1.037	1.033
	0.1	0.320	0.447	0.661	0.768	0.844	0.942	1.000	1.077	1.081	1.071	1.061	1.052	1.044	1.039	1.035	1.032
	0.15	0.318	0.444	0.657	0.764	0.839	0.936	0.994	1.072	1.076	1.067	1.057	1.048	1.041	1.036	1.032	1.029
	0.2	0.316	0.442	0.653	0.760	0.835	0.932	0.990	1.068	1.073	1.065	1.055	1.046	1.039	1.034	1.030	1.028
c_L/r	0.4	0.312	0.436	0.645	0.750	0.824	0.921	0.979	1.060	1.067	1.060	1.051	1.043	1.037	1.032	1.028	1.025
	0.6	0.309	0.432	0.639	0.744	0.818	0.915	0.974	1.056	1.065	1.059	1.050	1.043	1.037	1.032	1.029	1.026
	0.8	0.307	0.429	0.635	0.739	0.814	0.911	0.970	1.054	1.064	1.059	1.051	1.044	1.038	1.034	1.030	1.028
	1.0	0.305	0.426	0.632	0.736	0.810	0.907	0.966	1.052	1.064	1.059	1.052	1.045	1.040	1.035	1.032	1.030
	1.2	0.303	0.424	0.629	0.733	0.807	0.904	0.964	1.051	1.064	1.060	1.053	1.047	1.041	1.037	1.034	1.032
	1.4	0.302	0.422	0.626	0.730	0.804	0.901	0.961	1.050	1.064	1.061	1.054	1.048	1.043	1.039	1.036	1.033
	1.6	0.301	0.421	0.624	0.727	0.801	0.899	0.959	1.049	1.063	1.061	1.055	1.049	1.044	1.040	1.037	1.035
	1.8	0.300	0.419	0.622	0.725	0.799	0.897	0.957	1.048	1.063	1.062	1.056	1.051	1.046	1.042	1.039	1.037
	2.0	0.299	0.418	0.620	0.723	0.797	0.895	0.955	1.047	1.063	1.062	1.057	1.052	1.047	1.044	1.041	1.039

Table 22: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.70$ and $r/W = 0.10$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.331	0.330	0.328	0.327	0.325	0.323	0.322	0.318	0.315	0.314	0.313	0.312	0.311	0.310	0.310	0.309
	0.02	0.462	0.461	0.458	0.456	0.454	0.452	0.449	0.444	0.441	0.439	0.437	0.436	0.435	0.434	0.433	0.433
	0.05	0.683	0.681	0.677	0.674	0.672	0.668	0.665	0.657	0.653	0.650	0.648	0.646	0.645	0.644	0.643	0.642
	0.075	0.793	0.791	0.787	0.784	0.781	0.776	0.773	0.764	0.760	0.757	0.755	0.753	0.752	0.750	0.750	0.749
	0.1	0.871	0.869	0.864	0.861	0.858	0.853	0.849	0.840	0.835	0.833	0.830	0.829	0.828	0.827	0.826	0.825
	0.15	0.972	0.970	0.965	0.961	0.958	0.952	0.948	0.939	0.935	0.932	0.931	0.929	0.929	0.928	0.927	0.927
	0.2	1.032	1.029	1.024	1.020	1.017	1.011	1.007	0.999	0.995	0.993	0.992	0.991	0.990	0.990	0.990	0.990
	0.4	1.112	1.110	1.105	1.101	1.098	1.093	1.090	1.083	1.082	1.082	1.083	1.084	1.085	1.087	1.088	1.090
	0.6	1.118	1.116	1.111	1.108	1.105	1.101	1.098	1.094	1.094	1.096	1.099	1.101	1.104	1.106	1.109	1.111
	0.8	1.111	1.109	1.104	1.101	1.099	1.095	1.093	1.091	1.092	1.095	1.099	1.102	1.106	1.109	1.112	1.116
	1.0	1.103	1.102	1.098	1.095	1.093	1.089	1.087	1.086	1.089	1.093	1.097	1.101	1.105	1.109	1.113	1.117
	1.2	1.098	1.097	1.093	1.090	1.088	1.086	1.084	1.083	1.087	1.091	1.096	1.101	1.106	1.110	1.115	1.119
	1.4	1.096	1.095	1.091	1.089	1.087	1.084	1.083	1.083	1.087	1.092	1.097	1.103	1.108	1.113	1.118	1.123
	1.6	1.097	1.095	1.092	1.090	1.088	1.086	1.084	1.085	1.090	1.095	1.101	1.106	1.112	1.118	1.123	1.128
	1.8	1.099	1.098	1.095	1.093	1.091	1.089	1.088	1.089	1.094	1.100	1.106	1.112	1.118	1.124	1.130	1.136
	2.0	1.104	1.103	1.100	1.098	1.097	1.095	1.094	1.096	1.101	1.107	1.114	1.120	1.127	1.133	1.139	1.146

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.329	0.460	0.680	0.790	0.867	0.968	1.027	1.106	1.110	1.100	1.090	1.081	1.075	1.070	1.067	1.065
	0.02	0.328	0.459	0.678	0.788	0.866	0.966	1.025	1.104	1.108	1.099	1.088	1.080	1.074	1.069	1.066	1.064
	0.05	0.326	0.456	0.674	0.784	0.861	0.961	1.019	1.099	1.103	1.094	1.084	1.076	1.070	1.066	1.063	1.061
	0.075	0.325	0.454	0.672	0.780	0.857	0.957	1.016	1.095	1.100	1.091	1.082	1.074	1.068	1.064	1.061	1.059
	0.1	0.324	0.453	0.669	0.778	0.854	0.954	1.012	1.092	1.097	1.089	1.079	1.072	1.066	1.062	1.059	1.058
	0.15	0.322	0.450	0.665	0.773	0.849	0.948	1.007	1.087	1.093	1.085	1.076	1.069	1.063	1.060	1.057	1.056
	0.2	0.320	0.448	0.662	0.769	0.846	0.944	1.003	1.084	1.090	1.083	1.074	1.067	1.062	1.058	1.056	1.054
	0.4	0.316	0.442	0.654	0.761	0.837	0.936	0.995	1.078	1.086	1.081	1.073	1.067	1.062	1.058	1.056	1.055
	0.6	0.314	0.439	0.651	0.757	0.833	0.932	0.991	1.077	1.087	1.083	1.076	1.070	1.065	1.062	1.060	1.060
	0.8	0.313	0.438	0.648	0.755	0.830	0.930	0.990	1.078	1.090	1.086	1.080	1.075	1.070	1.068	1.066	1.065
	1.0	0.312	0.436	0.647	0.753	0.829	0.929	0.990	1.079	1.093	1.090	1.085	1.080	1.076	1.073	1.071	1.071
	1.2	0.311	0.435	0.646	0.752	0.828	0.929	0.990	1.082	1.097	1.095	1.090	1.085	1.081	1.079	1.077	1.077
	1.4	0.311	0.435	0.645	0.752	0.828	0.929	0.990	1.084	1.100	1.099	1.095	1.091	1.087	1.085	1.084	1.083
	1.6	0.311	0.435	0.645	0.752	0.828	0.930	0.992	1.087	1.105	1.104	1.101	1.097	1.094	1.091	1.090	1.090
	1.8	0.311	0.435	0.645	0.752	0.829	0.931	0.993	1.091	1.109	1.110	1.106	1.103	1.100	1.098	1.097	1.097
	2.0	0.311	0.435	0.646	0.753	0.830	0.933	0.996	1.095	1.114	1.116	1.113	1.110	1.107	1.106	1.105	1.105

Table 23: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters H/W = 4.00, d/W = 0.70 and r/W = 0.15.*

F_{aL}	c_R/r															
c_L/r	0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
0.01	0.340	0.339	0.337	0.336	0.335	0.333	0.331	0.328	0.327	0.326	0.326	0.326	0.327	0.327	0.327	0.328
0.02	0.475	0.474	0.471	0.469	0.468	0.465	0.463	0.459	0.457	0.457	0.456	0.457	0.457	0.458	0.458	0.459
0.05	0.702	0.701	0.696	0.694	0.691	0.687	0.685	0.679	0.677	0.676	0.676	0.677	0.678	0.679	0.680	0.681
0.075	0.816	0.814	0.809	0.806	0.803	0.799	0.796	0.789	0.787	0.787	0.787	0.788	0.789	0.791	0.792	0.794
0.1	0.896	0.894	0.889	0.885	0.882	0.878	0.874	0.868	0.866	0.866	0.867	0.868	0.869	0.871	0.873	0.875
0.15	1.000	0.998	0.993	0.989	0.986	0.981	0.978	0.971	0.970	0.971	0.972	0.974	0.976	0.979	0.981	0.984
0.2	1.062	1.060	1.054	1.051	1.047	1.043	1.039	1.033	1.033	1.034	1.037	1.039	1.042	1.045	1.049	1.052
0.4	1.150	1.148	1.143	1.139	1.136	1.132	1.129	1.126	1.129	1.133	1.138	1.143	1.149	1.154	1.159	1.165
0.6	1.163	1.161	1.156	1.153	1.150	1.147	1.144	1.144	1.149	1.156	1.163	1.170	1.177	1.184	1.191	1.198
0.8	1.164	1.162	1.158	1.155	1.153	1.150	1.148	1.150	1.157	1.165	1.173	1.182	1.190	1.199	1.207	1.215
1.0	1.167	1.165	1.161	1.158	1.156	1.154	1.153	1.156	1.164	1.174	1.184	1.194	1.203	1.213	1.222	1.232
1.2	1.174	1.173	1.169	1.166	1.165	1.163	1.162	1.167	1.176	1.187	1.198	1.209	1.220	1.231	1.241	1.252
1.4	1.188	1.186	1.182	1.180	1.179	1.177	1.177	1.183	1.193	1.206	1.218	1.230	1.242	1.254	1.266	1.278
1.6	1.207	1.206	1.202	1.200	1.199	1.197	1.197	1.205	1.217	1.230	1.244	1.258	1.271	1.284	1.297	1.310
1.8	1.234	1.232	1.229	1.227	1.226	1.225	1.225	1.234	1.247	1.262	1.278	1.293	1.308	1.322	1.337	1.351
2.0	1.269	1.267	1.264	1.262	1.261	1.260	1.261	1.271	1.286	1.303	1.320	1.337	1.354	1.370	1.386	1.402

F_{aR}	c_R/r															
c_L/r	0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
0.01	0.335	0.468	0.692	0.804	0.883	0.986	1.047	1.129	1.135	1.127	1.119	1.112	1.107	1.105	1.104	1.104
0.02	0.334	0.467	0.691	0.803	0.882	0.984	1.044	1.127	1.133	1.125	1.117	1.110	1.106	1.103	1.103	1.103
0.05	0.332	0.465	0.687	0.798	0.877	0.979	1.039	1.122	1.128	1.121	1.113	1.107	1.102	1.100	1.100	1.100
0.075	0.331	0.463	0.684	0.795	0.873	0.975	1.035	1.118	1.125	1.118	1.110	1.104	1.100	1.098	1.098	1.099
0.1	0.330	0.461	0.682	0.792	0.870	0.972	1.032	1.115	1.123	1.116	1.109	1.103	1.099	1.097	1.096	1.097
0.15	0.328	0.459	0.678	0.788	0.866	0.967	1.028	1.111	1.119	1.113	1.106	1.101	1.097	1.095	1.095	1.096
0.2	0.327	0.457	0.676	0.785	0.863	0.964	1.024	1.109	1.117	1.112	1.105	1.100	1.096	1.095	1.095	1.096
0.4	0.324	0.453	0.670	0.780	0.857	0.959	1.020	1.107	1.118	1.114	1.109	1.104	1.101	1.100	1.100	1.102
0.6	0.323	0.452	0.670	0.779	0.857	0.959	1.021	1.111	1.125	1.122	1.117	1.113	1.111	1.110	1.110	1.112
0.8	0.323	0.452	0.670	0.780	0.859	0.962	1.025	1.118	1.133	1.132	1.128	1.124	1.122	1.122	1.122	1.124
1.0	0.324	0.454	0.672	0.783	0.862	0.966	1.030	1.126	1.143	1.143	1.140	1.137	1.135	1.135	1.136	1.138
1.2	0.325	0.455	0.675	0.787	0.866	0.972	1.037	1.136	1.155	1.156	1.153	1.151	1.149	1.149	1.150	1.152
1.4	0.327	0.458	0.679	0.792	0.872	0.979	1.044	1.147	1.167	1.169	1.168	1.166	1.165	1.165	1.166	1.168
1.6	0.329	0.461	0.684	0.798	0.879	0.987	1.054	1.159	1.182	1.185	1.184	1.182	1.182	1.182	1.183	1.186
1.8	0.332	0.465	0.691	0.805	0.888	0.997	1.065	1.174	1.198	1.202	1.202	1.201	1.201	1.202	1.203	1.206
2.0	0.336	0.470	0.698	0.814	0.898	1.010	1.079	1.191	1.217	1.223	1.223	1.223	1.223	1.224	1.226	1.228

Table 24: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.70$ and $r/W = 0.20$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.355	0.354	0.352	0.351	0.349	0.348	0.347	0.345	0.345	0.346	0.347	0.349	0.350	0.352	0.354	0.356
	0.02	0.496	0.495	0.492	0.490	0.489	0.486	0.485	0.482	0.483	0.484	0.486	0.488	0.490	0.493	0.495	0.498
	0.05	0.733	0.731	0.727	0.724	0.722	0.719	0.716	0.713	0.714	0.716	0.720	0.723	0.727	0.730	0.734	0.739
	0.075	0.851	0.849	0.845	0.842	0.839	0.835	0.833	0.829	0.831	0.834	0.838	0.842	0.846	0.851	0.856	0.861
	0.1	0.935	0.933	0.928	0.925	0.922	0.918	0.915	0.912	0.914	0.918	0.923	0.927	0.933	0.938	0.944	0.949
	0.15	1.045	1.043	1.037	1.034	1.031	1.026	1.024	1.021	1.025	1.030	1.036	1.042	1.048	1.055	1.061	1.068
	0.2	1.111	1.109	1.103	1.100	1.097	1.092	1.090	1.088	1.093	1.099	1.106	1.113	1.121	1.128	1.136	1.144
c_L/r	0.4	1.213	1.210	1.205	1.201	1.199	1.195	1.193	1.196	1.204	1.215	1.225	1.236	1.247	1.258	1.269	1.279
	0.6	1.240	1.238	1.233	1.230	1.227	1.224	1.223	1.229	1.241	1.255	1.268	1.282	1.296	1.309	1.322	1.335
	0.8	1.259	1.257	1.253	1.250	1.248	1.246	1.246	1.254	1.269	1.285	1.302	1.318	1.334	1.350	1.365	1.380
	1.0	1.286	1.284	1.280	1.278	1.276	1.274	1.275	1.286	1.304	1.323	1.342	1.361	1.379	1.398	1.415	1.433
	1.2	1.327	1.325	1.321	1.319	1.317	1.316	1.317	1.331	1.352	1.374	1.396	1.418	1.440	1.460	1.481	1.501
	1.4	1.385	1.383	1.380	1.378	1.376	1.376	1.378	1.395	1.419	1.445	1.471	1.496	1.521	1.546	1.569	1.592
	1.6	1.469	1.467	1.464	1.462	1.461	1.461	1.464	1.484	1.513	1.544	1.574	1.605	1.634	1.663	1.691	1.718
	1.8	1.591	1.590	1.586	1.584	1.584	1.585	1.588	1.614	1.649	1.685	1.723	1.759	1.795	1.830	1.864	1.897
	2.0	1.782	1.780	1.777	1.775	1.775	1.777	1.781	1.815	1.858	1.905	1.952	1.999	2.044	2.089	2.132	2.174

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.343	0.480	0.709	0.824	0.905	1.011	1.073	1.160	1.169	1.163	1.157	1.153	1.151	1.153	1.156	1.162
	0.02	0.343	0.479	0.708	0.822	0.903	1.009	1.071	1.158	1.167	1.161	1.155	1.151	1.150	1.151	1.155	1.160
	0.05	0.341	0.476	0.704	0.818	0.899	1.003	1.066	1.153	1.162	1.157	1.152	1.148	1.147	1.148	1.152	1.158
	0.075	0.339	0.475	0.701	0.815	0.895	1.000	1.062	1.149	1.159	1.155	1.149	1.146	1.145	1.146	1.150	1.156
	0.1	0.338	0.473	0.699	0.813	0.893	0.997	1.060	1.147	1.157	1.153	1.148	1.145	1.144	1.145	1.149	1.156
	0.15	0.337	0.471	0.696	0.809	0.889	0.994	1.056	1.144	1.155	1.151	1.147	1.144	1.143	1.145	1.149	1.155
	0.2	0.336	0.470	0.694	0.807	0.887	0.992	1.054	1.143	1.154	1.151	1.147	1.144	1.144	1.146	1.150	1.157
c_L/r	0.4	0.335	0.469	0.693	0.806	0.887	0.992	1.056	1.148	1.163	1.161	1.158	1.156	1.156	1.159	1.163	1.170
	0.6	0.337	0.471	0.697	0.811	0.893	1.000	1.065	1.162	1.178	1.178	1.176	1.175	1.175	1.178	1.182	1.189
	0.8	0.339	0.475	0.704	0.819	0.902	1.011	1.077	1.179	1.198	1.200	1.198	1.197	1.198	1.201	1.205	1.212
	1.0	0.343	0.481	0.712	0.830	0.913	1.025	1.093	1.199	1.221	1.224	1.223	1.223	1.224	1.227	1.232	1.238
	1.2	0.348	0.488	0.723	0.843	0.928	1.042	1.112	1.223	1.248	1.253	1.253	1.253	1.255	1.258	1.263	1.269
	1.4	0.355	0.497	0.737	0.859	0.947	1.064	1.136	1.253	1.280	1.287	1.288	1.289	1.291	1.294	1.299	1.305
	1.6	0.363	0.509	0.755	0.881	0.971	1.091	1.167	1.289	1.320	1.328	1.331	1.333	1.335	1.339	1.343	1.349
	1.8	0.375	0.525	0.779	0.908	1.002	1.127	1.206	1.336	1.371	1.382	1.386	1.389	1.392	1.395	1.400	1.405
	2.0	0.390	0.546	0.811	0.947	1.044	1.176	1.259	1.400	1.439	1.453	1.459	1.463	1.467	1.471	1.476	1.481

Table 25: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.80$ and $r/W = 0.05$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.325	0.325	0.323	0.321	0.320	0.318	0.316	0.311	0.309	0.306	0.305	0.303	0.301	0.300	0.299	0.298
	0.02	0.454	0.453	0.451	0.449	0.447	0.444	0.442	0.435	0.431	0.428	0.426	0.423	0.421	0.420	0.418	0.416
	0.05	0.672	0.670	0.666	0.663	0.661	0.656	0.653	0.644	0.639	0.634	0.631	0.628	0.625	0.623	0.620	0.618
	0.075	0.780	0.779	0.774	0.771	0.768	0.763	0.759	0.749	0.743	0.739	0.735	0.732	0.729	0.726	0.723	0.721
	0.1	0.857	0.855	0.850	0.847	0.843	0.838	0.834	0.824	0.817	0.813	0.809	0.805	0.802	0.799	0.797	0.794
	0.15	0.956	0.954	0.949	0.945	0.941	0.936	0.932	0.921	0.914	0.910	0.906	0.903	0.900	0.897	0.894	0.892
	0.2	1.014	1.012	1.007	1.003	0.999	0.994	0.989	0.979	0.973	0.968	0.965	0.962	0.959	0.957	0.954	0.952
	0.4	1.091	1.089	1.084	1.080	1.077	1.071	1.068	1.059	1.055	1.053	1.051	1.049	1.048	1.046	1.045	1.044
	0.6	1.094	1.092	1.087	1.083	1.080	1.076	1.073	1.066	1.064	1.063	1.062	1.062	1.061	1.061	1.060	1.060
	0.8	1.083	1.081	1.077	1.073	1.071	1.067	1.064	1.059	1.058	1.058	1.058	1.058	1.058	1.059	1.059	1.059
	1.0	1.071	1.070	1.066	1.063	1.060	1.057	1.054	1.050	1.050	1.050	1.051	1.052	1.052	1.053	1.053	1.054
	1.2	1.061	1.060	1.056	1.054	1.051	1.048	1.046	1.042	1.042	1.043	1.044	1.045	1.046	1.047	1.048	1.049
	1.4	1.054	1.052	1.049	1.046	1.044	1.041	1.039	1.036	1.037	1.038	1.039	1.040	1.041	1.042	1.043	1.044
	1.6	1.048	1.047	1.043	1.041	1.039	1.036	1.035	1.032	1.032	1.033	1.035	1.036	1.038	1.039	1.040	1.041
	1.8	1.044	1.042	1.039	1.037	1.035	1.033	1.031	1.029	1.029	1.030	1.032	1.033	1.035	1.036	1.037	1.039
	2.0	1.040	1.039	1.036	1.034	1.033	1.030	1.028	1.026	1.027	1.028	1.030	1.031	1.033	1.034	1.036	1.037

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.325	0.454	0.672	0.780	0.857	0.956	1.014	1.091	1.093	1.082	1.070	1.060	1.052	1.046	1.041	1.038
	0.02	0.324	0.453	0.670	0.778	0.855	0.954	1.012	1.089	1.091	1.080	1.069	1.059	1.051	1.045	1.040	1.037
	0.05	0.322	0.451	0.666	0.774	0.850	0.948	1.006	1.083	1.086	1.076	1.065	1.055	1.047	1.042	1.037	1.034
	0.075	0.321	0.449	0.663	0.771	0.846	0.945	1.002	1.079	1.083	1.073	1.062	1.052	1.045	1.039	1.035	1.032
	0.1	0.319	0.447	0.661	0.768	0.843	0.941	0.999	1.076	1.080	1.070	1.059	1.050	1.043	1.037	1.033	1.030
	0.15	0.317	0.444	0.656	0.763	0.838	0.936	0.993	1.071	1.075	1.066	1.056	1.047	1.040	1.035	1.031	1.027
	0.2	0.316	0.442	0.653	0.759	0.834	0.931	0.989	1.067	1.072	1.063	1.053	1.045	1.038	1.033	1.029	1.026
	0.4	0.311	0.435	0.644	0.749	0.823	0.921	0.978	1.059	1.066	1.058	1.049	1.041	1.035	1.030	1.026	1.023
	0.6	0.308	0.431	0.639	0.743	0.817	0.914	0.972	1.055	1.063	1.057	1.049	1.041	1.035	1.030	1.027	1.024
	0.8	0.306	0.428	0.634	0.738	0.812	0.910	0.968	1.053	1.062	1.057	1.049	1.042	1.036	1.032	1.028	1.025
	1.0	0.304	0.426	0.631	0.735	0.809	0.906	0.965	1.051	1.062	1.057	1.050	1.043	1.037	1.033	1.030	1.027
	1.2	0.303	0.424	0.628	0.731	0.805	0.903	0.962	1.049	1.061	1.058	1.051	1.044	1.039	1.034	1.031	1.028
	1.4	0.301	0.422	0.625	0.728	0.802	0.900	0.959	1.048	1.061	1.058	1.051	1.045	1.040	1.036	1.032	1.030
	1.6	0.300	0.420	0.623	0.726	0.799	0.897	0.957	1.046	1.061	1.058	1.052	1.046	1.041	1.037	1.034	1.031
	1.8	0.299	0.418	0.621	0.723	0.797	0.895	0.954	1.045	1.060	1.058	1.053	1.047	1.042	1.038	1.035	1.033
	2.0	0.298	0.417	0.619	0.721	0.795	0.892	0.952	1.044	1.060	1.059	1.053	1.048	1.043	1.039	1.036	1.034

Table 26: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.80$ and $r/W = 0.10$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.329	0.328	0.326	0.325	0.324	0.321	0.320	0.316	0.313	0.312	0.310	0.309	0.308	0.307	0.307	0.306
	0.02	0.460	0.459	0.456	0.454	0.453	0.450	0.447	0.442	0.438	0.436	0.434	0.433	0.432	0.430	0.430	0.429
	0.05	0.680	0.678	0.674	0.671	0.669	0.665	0.662	0.654	0.649	0.646	0.644	0.642	0.640	0.639	0.637	0.636
	0.075	0.790	0.788	0.783	0.780	0.777	0.773	0.769	0.760	0.755	0.752	0.749	0.747	0.746	0.744	0.743	0.742
	0.1	0.867	0.865	0.860	0.857	0.854	0.849	0.845	0.836	0.831	0.827	0.825	0.823	0.821	0.820	0.819	0.818
	0.15	0.968	0.966	0.960	0.957	0.953	0.948	0.944	0.934	0.930	0.927	0.924	0.923	0.921	0.920	0.919	0.919
	0.2	1.027	1.025	1.019	1.015	1.012	1.007	1.003	0.993	0.989	0.986	0.985	0.983	0.982	0.982	0.981	0.981
c_L/r	0.4	1.106	1.104	1.099	1.095	1.092	1.087	1.084	1.077	1.075	1.074	1.075	1.075	1.076	1.076	1.077	1.078
	0.6	1.111	1.109	1.104	1.101	1.098	1.094	1.091	1.086	1.086	1.087	1.089	1.091	1.092	1.094	1.096	1.098
	0.8	1.103	1.101	1.097	1.093	1.091	1.087	1.085	1.082	1.083	1.085	1.088	1.090	1.093	1.095	1.098	1.100
	1.0	1.094	1.092	1.088	1.085	1.083	1.080	1.078	1.076	1.078	1.081	1.084	1.087	1.090	1.093	1.097	1.100
	1.2	1.087	1.086	1.082	1.080	1.077	1.075	1.073	1.071	1.074	1.077	1.081	1.085	1.089	1.092	1.096	1.099
	1.4	1.083	1.082	1.078	1.076	1.074	1.071	1.070	1.069	1.072	1.076	1.080	1.084	1.088	1.092	1.096	1.100
	1.6	1.082	1.080	1.077	1.075	1.073	1.071	1.069	1.069	1.072	1.076	1.081	1.085	1.090	1.094	1.098	1.102
	1.8	1.082	1.081	1.077	1.075	1.074	1.072	1.070	1.070	1.074	1.079	1.083	1.088	1.093	1.097	1.102	1.106
	2.0	1.084	1.083	1.080	1.078	1.076	1.074	1.073	1.074	1.078	1.082	1.087	1.093	1.098	1.102	1.107	1.112

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.328	0.459	0.678	0.788	0.865	0.965	1.024	1.103	1.106	1.097	1.086	1.077	1.071	1.066	1.063	1.061
	0.02	0.327	0.458	0.677	0.786	0.863	0.963	1.022	1.101	1.104	1.095	1.084	1.076	1.069	1.065	1.061	1.060
	0.05	0.325	0.455	0.673	0.781	0.858	0.958	1.017	1.095	1.099	1.090	1.080	1.072	1.066	1.061	1.058	1.057
	0.075	0.324	0.453	0.670	0.778	0.855	0.954	1.013	1.092	1.096	1.087	1.078	1.069	1.063	1.059	1.056	1.055
	0.1	0.323	0.451	0.667	0.775	0.852	0.951	1.009	1.088	1.093	1.085	1.075	1.067	1.062	1.057	1.055	1.053
	0.15	0.321	0.449	0.663	0.771	0.847	0.946	1.004	1.084	1.089	1.081	1.072	1.064	1.059	1.055	1.052	1.051
	0.2	0.319	0.446	0.660	0.767	0.843	0.942	1.000	1.080	1.086	1.079	1.070	1.063	1.057	1.053	1.051	1.050
c_L/r	0.4	0.315	0.441	0.652	0.758	0.834	0.932	0.991	1.073	1.082	1.076	1.068	1.061	1.056	1.053	1.051	1.050
	0.6	0.313	0.438	0.648	0.754	0.829	0.928	0.987	1.072	1.082	1.077	1.070	1.064	1.059	1.056	1.054	1.053
	0.8	0.311	0.435	0.645	0.751	0.826	0.925	0.985	1.072	1.083	1.079	1.073	1.067	1.063	1.060	1.058	1.057
	1.0	0.310	0.434	0.643	0.749	0.824	0.923	0.983	1.072	1.085	1.082	1.077	1.071	1.067	1.064	1.063	1.062
	1.2	0.309	0.433	0.641	0.747	0.822	0.922	0.983	1.073	1.088	1.086	1.080	1.075	1.072	1.069	1.067	1.067
	1.4	0.308	0.432	0.640	0.746	0.821	0.921	0.982	1.075	1.090	1.089	1.084	1.080	1.076	1.074	1.072	1.072
	1.6	0.308	0.431	0.639	0.745	0.821	0.921	0.983	1.077	1.093	1.092	1.088	1.084	1.081	1.078	1.077	1.077
	1.8	0.307	0.430	0.639	0.745	0.820	0.921	0.983	1.079	1.096	1.096	1.092	1.089	1.085	1.083	1.082	1.082
	2.0	0.307	0.430	0.639	0.745	0.821	0.922	0.984	1.081	1.100	1.100	1.097	1.093	1.091	1.089	1.088	1.088

Table 27: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.80$ and $r/W = 0.15$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.336	0.335	0.333	0.332	0.331	0.329	0.327	0.324	0.322	0.321	0.321	0.321	0.321	0.321	0.321	0.321
	0.02	0.470	0.469	0.466	0.464	0.462	0.460	0.458	0.453	0.451	0.450	0.449	0.449	0.449	0.449	0.449	0.450
	0.05	0.694	0.693	0.689	0.686	0.684	0.680	0.677	0.670	0.668	0.666	0.666	0.665	0.665	0.666	0.667	0.667
	0.075	0.807	0.805	0.800	0.797	0.794	0.790	0.787	0.780	0.777	0.776	0.775	0.775	0.775	0.776	0.777	0.778
	0.1	0.886	0.884	0.879	0.876	0.873	0.868	0.865	0.857	0.854	0.853	0.853	0.853	0.854	0.855	0.856	0.858
	0.15	0.989	0.987	0.982	0.978	0.975	0.970	0.966	0.959	0.956	0.956	0.956	0.957	0.958	0.960	0.962	0.964
	0.2	1.050	1.048	1.042	1.039	1.035	1.030	1.027	1.020	1.018	1.019	1.020	1.021	1.023	1.025	1.027	1.030
c_L/r	0.4	1.135	1.133	1.127	1.124	1.121	1.116	1.113	1.109	1.110	1.113	1.117	1.120	1.124	1.128	1.133	1.137
	0.6	1.144	1.143	1.138	1.134	1.132	1.128	1.126	1.124	1.127	1.132	1.137	1.143	1.148	1.154	1.159	1.165
	0.8	1.142	1.140	1.136	1.133	1.130	1.127	1.125	1.125	1.130	1.136	1.143	1.150	1.156	1.163	1.169	1.176
	1.0	1.140	1.138	1.134	1.131	1.129	1.127	1.125	1.127	1.133	1.140	1.148	1.155	1.163	1.170	1.177	1.185
	1.2	1.142	1.140	1.136	1.134	1.132	1.129	1.128	1.131	1.138	1.146	1.155	1.163	1.171	1.180	1.188	1.196
	1.4	1.147	1.146	1.142	1.140	1.138	1.136	1.136	1.139	1.147	1.156	1.165	1.175	1.184	1.193	1.202	1.210
	1.6	1.158	1.156	1.153	1.151	1.149	1.147	1.147	1.151	1.160	1.170	1.180	1.190	1.200	1.210	1.220	1.229
	1.8	1.172	1.171	1.168	1.166	1.165	1.163	1.163	1.168	1.178	1.188	1.200	1.210	1.221	1.232	1.242	1.253
	2.0	1.192	1.191	1.188	1.186	1.185	1.183	1.183	1.190	1.200	1.212	1.224	1.236	1.248	1.259	1.270	1.282

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.333	0.466	0.689	0.800	0.879	0.981	1.041	1.122	1.128	1.120	1.111	1.105	1.101	1.099	1.099	1.100
	0.02	0.333	0.465	0.687	0.798	0.877	0.979	1.039	1.120	1.126	1.118	1.110	1.103	1.099	1.097	1.097	1.099
	0.05	0.331	0.462	0.683	0.794	0.872	0.973	1.033	1.115	1.121	1.114	1.106	1.100	1.096	1.094	1.094	1.096
	0.075	0.329	0.460	0.681	0.791	0.869	0.970	1.029	1.111	1.118	1.111	1.103	1.097	1.094	1.092	1.092	1.094
	0.1	0.328	0.459	0.678	0.788	0.866	0.967	1.026	1.108	1.115	1.109	1.101	1.095	1.092	1.091	1.091	1.093
	0.15	0.326	0.456	0.674	0.784	0.861	0.962	1.021	1.104	1.112	1.105	1.098	1.093	1.090	1.089	1.089	1.091
	0.2	0.325	0.454	0.672	0.781	0.858	0.958	1.018	1.101	1.109	1.104	1.097	1.092	1.089	1.088	1.089	1.091
c_L/r	0.4	0.322	0.450	0.665	0.774	0.851	0.952	1.012	1.098	1.108	1.104	1.098	1.094	1.092	1.091	1.092	1.095
	0.6	0.320	0.448	0.663	0.772	0.849	0.950	1.011	1.100	1.112	1.110	1.105	1.101	1.099	1.099	1.100	1.103
	0.8	0.320	0.447	0.663	0.772	0.849	0.951	1.013	1.104	1.118	1.117	1.113	1.109	1.108	1.108	1.109	1.112
	1.0	0.320	0.448	0.663	0.772	0.850	0.953	1.016	1.110	1.125	1.125	1.121	1.118	1.117	1.117	1.119	1.122
	1.2	0.320	0.448	0.665	0.774	0.852	0.956	1.019	1.116	1.133	1.134	1.131	1.128	1.127	1.128	1.130	1.133
	1.4	0.321	0.449	0.666	0.777	0.855	0.960	1.024	1.123	1.142	1.143	1.141	1.139	1.138	1.139	1.141	1.144
	1.6	0.322	0.451	0.669	0.780	0.859	0.965	1.030	1.131	1.151	1.154	1.152	1.151	1.150	1.151	1.153	1.157
	1.8	0.324	0.453	0.673	0.784	0.864	0.971	1.037	1.140	1.162	1.165	1.164	1.163	1.163	1.164	1.166	1.170
	2.0	0.326	0.456	0.677	0.789	0.870	0.978	1.045	1.151	1.174	1.178	1.178	1.177	1.177	1.178	1.181	1.185

***Table 28:** Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters H/W = 4.00, d/W = 0.80 and r/W = 0.20.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.347	0.346	0.344	0.343	0.342	0.340	0.339	0.336	0.336	0.336	0.337	0.338	0.339	0.340	0.342	0.343
	0.02	0.485	0.484	0.482	0.480	0.478	0.476	0.474	0.471	0.470	0.471	0.472	0.473	0.474	0.476	0.478	0.481
	0.05	0.717	0.716	0.712	0.709	0.706	0.703	0.700	0.696	0.696	0.697	0.699	0.701	0.703	0.706	0.709	0.713
	0.075	0.833	0.831	0.827	0.824	0.821	0.817	0.814	0.809	0.809	0.811	0.813	0.816	0.819	0.823	0.827	0.831
	0.1	0.915	0.913	0.908	0.905	0.902	0.898	0.895	0.890	0.890	0.893	0.895	0.899	0.903	0.907	0.911	0.916
	0.15	1.022	1.020	1.015	1.011	1.008	1.003	1.000	0.996	0.997	1.001	1.005	1.009	1.014	1.019	1.025	1.031
	0.2	1.086	1.084	1.079	1.075	1.072	1.067	1.064	1.061	1.063	1.067	1.072	1.077	1.083	1.089	1.096	1.102
	0.4	1.180	1.178	1.173	1.169	1.166	1.162	1.160	1.160	1.166	1.173	1.182	1.190	1.198	1.207	1.216	1.225
	0.6	1.199	1.198	1.192	1.189	1.187	1.184	1.182	1.185	1.193	1.204	1.214	1.225	1.235	1.246	1.257	1.268
	0.8	1.209	1.207	1.202	1.199	1.197	1.195	1.194	1.199	1.209	1.222	1.234	1.246	1.258	1.271	1.283	1.295
	1.0	1.222	1.220	1.216	1.213	1.211	1.209	1.209	1.216	1.228	1.242	1.256	1.270	1.284	1.298	1.311	1.325
	1.2	1.243	1.241	1.237	1.235	1.233	1.232	1.232	1.240	1.255	1.270	1.286	1.302	1.317	1.333	1.348	1.363
	1.4	1.274	1.272	1.269	1.267	1.265	1.264	1.264	1.275	1.291	1.309	1.327	1.345	1.362	1.379	1.395	1.412
	1.6	1.318	1.317	1.313	1.311	1.310	1.309	1.310	1.323	1.341	1.361	1.381	1.401	1.420	1.439	1.458	1.476
	1.8	1.379	1.377	1.374	1.372	1.371	1.371	1.372	1.387	1.409	1.431	1.454	1.477	1.499	1.520	1.541	1.561
	2.0	1.462	1.461	1.458	1.456	1.455	1.455	1.457	1.475	1.500	1.527	1.553	1.579	1.604	1.629	1.653	1.676

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.341	0.476	0.704	0.817	0.898	1.002	1.064	1.149	1.158	1.153	1.147	1.145	1.145	1.149	1.155	1.165
	0.02	0.340	0.475	0.702	0.816	0.896	1.000	1.062	1.147	1.156	1.151	1.146	1.143	1.144	1.147	1.154	1.164
	0.05	0.338	0.472	0.698	0.811	0.891	0.995	1.056	1.142	1.151	1.147	1.142	1.139	1.140	1.144	1.151	1.161
	0.075	0.337	0.471	0.695	0.808	0.888	0.991	1.053	1.139	1.148	1.144	1.139	1.137	1.138	1.142	1.149	1.159
	0.1	0.335	0.469	0.693	0.806	0.885	0.988	1.050	1.136	1.146	1.142	1.138	1.136	1.137	1.141	1.148	1.158
	0.15	0.334	0.467	0.690	0.802	0.881	0.984	1.046	1.132	1.143	1.140	1.136	1.134	1.135	1.140	1.147	1.158
	0.2	0.333	0.465	0.688	0.799	0.878	0.982	1.043	1.131	1.142	1.139	1.135	1.134	1.136	1.140	1.148	1.158
	0.4	0.331	0.463	0.684	0.796	0.875	0.979	1.041	1.132	1.146	1.145	1.142	1.142	1.144	1.149	1.157	1.167
	0.6	0.331	0.463	0.686	0.798	0.878	0.983	1.046	1.141	1.157	1.157	1.155	1.155	1.158	1.163	1.171	1.182
	0.8	0.332	0.465	0.689	0.802	0.883	0.989	1.054	1.152	1.170	1.171	1.171	1.171	1.174	1.179	1.188	1.199
	1.0	0.335	0.468	0.694	0.808	0.890	0.998	1.064	1.165	1.185	1.188	1.188	1.189	1.192	1.198	1.206	1.217
	1.2	0.338	0.472	0.700	0.816	0.899	1.008	1.076	1.181	1.203	1.207	1.208	1.209	1.212	1.218	1.227	1.238
	1.4	0.341	0.478	0.708	0.826	0.910	1.021	1.090	1.199	1.223	1.228	1.230	1.232	1.235	1.241	1.249	1.261
	1.6	0.346	0.484	0.719	0.838	0.923	1.037	1.108	1.221	1.247	1.253	1.255	1.258	1.261	1.267	1.276	1.287
	1.8	0.352	0.493	0.731	0.853	0.940	1.057	1.129	1.247	1.275	1.283	1.286	1.288	1.292	1.298	1.306	1.317
	2.0	0.360	0.504	0.748	0.872	0.961	1.081	1.156	1.279	1.310	1.319	1.323	1.326	1.330	1.335	1.343	1.354

Table 29: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.90$ and $r/W = 0.05$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.325	0.324	0.322	0.321	0.319	0.317	0.316	0.311	0.308	0.306	0.304	0.302	0.301	0.299	0.298	0.297
	0.02	0.454	0.453	0.451	0.449	0.447	0.444	0.441	0.435	0.431	0.428	0.425	0.423	0.421	0.419	0.418	0.416
	0.05	0.671	0.670	0.666	0.663	0.660	0.656	0.653	0.644	0.638	0.634	0.630	0.627	0.625	0.622	0.620	0.618
	0.075	0.780	0.778	0.774	0.770	0.767	0.763	0.759	0.749	0.742	0.738	0.734	0.731	0.728	0.725	0.722	0.720
	0.1	0.856	0.855	0.850	0.846	0.843	0.838	0.834	0.823	0.817	0.812	0.808	0.804	0.801	0.798	0.796	0.793
	0.15	0.956	0.954	0.948	0.944	0.941	0.935	0.931	0.920	0.914	0.909	0.905	0.902	0.899	0.896	0.893	0.891
	0.2	1.014	1.012	1.006	1.002	0.999	0.993	0.989	0.978	0.972	0.967	0.964	0.961	0.958	0.955	0.953	0.951
c_L/r	0.4	1.090	1.088	1.083	1.079	1.076	1.071	1.067	1.058	1.054	1.052	1.050	1.048	1.047	1.045	1.044	1.042
	0.6	1.093	1.091	1.086	1.082	1.080	1.075	1.072	1.065	1.063	1.062	1.061	1.060	1.060	1.059	1.059	1.058
	0.8	1.082	1.080	1.076	1.072	1.070	1.066	1.063	1.058	1.057	1.056	1.057	1.057	1.057	1.057	1.057	1.057
	1.0	1.070	1.069	1.064	1.062	1.059	1.056	1.053	1.049	1.048	1.049	1.049	1.050	1.050	1.051	1.051	1.052
	1.2	1.060	1.059	1.055	1.052	1.050	1.047	1.045	1.041	1.041	1.042	1.042	1.043	1.044	1.045	1.046	1.046
	1.4	1.052	1.051	1.047	1.045	1.043	1.040	1.038	1.035	1.035	1.036	1.037	1.038	1.039	1.040	1.041	1.042
	1.6	1.046	1.045	1.042	1.039	1.038	1.035	1.033	1.030	1.030	1.031	1.033	1.034	1.035	1.036	1.037	1.038
	1.8	1.042	1.041	1.037	1.035	1.033	1.031	1.029	1.026	1.027	1.028	1.029	1.031	1.032	1.033	1.034	1.035
	2.0	1.038	1.037	1.034	1.032	1.030	1.028	1.026	1.024	1.024	1.026	1.027	1.028	1.030	1.031	1.032	1.033

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.325	0.454	0.671	0.780	0.856	0.955	1.014	1.090	1.092	1.081	1.070	1.060	1.052	1.045	1.041	1.037
	0.02	0.324	0.453	0.670	0.778	0.855	0.953	1.011	1.088	1.091	1.080	1.068	1.058	1.050	1.044	1.039	1.036
	0.05	0.322	0.450	0.666	0.774	0.850	0.948	1.006	1.083	1.086	1.075	1.064	1.054	1.047	1.041	1.036	1.033
	0.075	0.321	0.449	0.663	0.770	0.846	0.944	1.002	1.079	1.082	1.072	1.061	1.052	1.044	1.039	1.034	1.031
	0.1	0.319	0.447	0.660	0.767	0.843	0.941	0.998	1.076	1.079	1.070	1.059	1.050	1.042	1.037	1.032	1.029
	0.15	0.317	0.444	0.656	0.763	0.838	0.935	0.993	1.071	1.075	1.066	1.055	1.046	1.039	1.034	1.030	1.027
	0.2	0.316	0.441	0.653	0.759	0.834	0.931	0.989	1.067	1.072	1.063	1.053	1.044	1.037	1.032	1.028	1.025
c_L/r	0.4	0.311	0.435	0.644	0.749	0.823	0.920	0.978	1.058	1.065	1.057	1.048	1.040	1.034	1.029	1.025	1.023
	0.6	0.308	0.431	0.638	0.742	0.817	0.914	0.972	1.054	1.063	1.056	1.048	1.040	1.034	1.029	1.026	1.023
	0.8	0.306	0.428	0.634	0.738	0.812	0.909	0.968	1.052	1.062	1.056	1.048	1.041	1.035	1.030	1.027	1.024
	1.0	0.304	0.425	0.630	0.734	0.808	0.905	0.964	1.050	1.061	1.056	1.049	1.042	1.036	1.032	1.028	1.026
	1.2	0.302	0.423	0.627	0.731	0.804	0.902	0.961	1.048	1.060	1.056	1.049	1.043	1.037	1.033	1.030	1.027
	1.4	0.301	0.421	0.625	0.728	0.801	0.899	0.958	1.047	1.060	1.057	1.050	1.044	1.038	1.034	1.031	1.028
	1.6	0.300	0.419	0.622	0.725	0.798	0.896	0.955	1.045	1.059	1.057	1.051	1.045	1.039	1.035	1.032	1.030
	1.8	0.298	0.418	0.620	0.722	0.796	0.893	0.953	1.044	1.059	1.057	1.051	1.045	1.040	1.036	1.033	1.031
	2.0	0.297	0.416	0.618	0.720	0.793	0.891	0.951	1.042	1.058	1.057	1.051	1.046	1.041	1.037	1.034	1.032

Table 30: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.90$ and $r/W = 0.10$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.328	0.327	0.325	0.324	0.323	0.321	0.319	0.315	0.312	0.310	0.309	0.308	0.307	0.306	0.305	0.305
	0.02	0.459	0.458	0.455	0.453	0.451	0.448	0.446	0.440	0.437	0.435	0.433	0.431	0.430	0.429	0.428	0.427
	0.05	0.678	0.677	0.673	0.670	0.667	0.663	0.660	0.652	0.647	0.644	0.641	0.639	0.637	0.636	0.634	0.633
	0.075	0.788	0.786	0.781	0.778	0.775	0.771	0.767	0.758	0.753	0.749	0.746	0.744	0.742	0.741	0.739	0.738
	0.1	0.865	0.863	0.858	0.855	0.852	0.847	0.843	0.833	0.828	0.824	0.822	0.819	0.818	0.816	0.815	0.814
	0.15	0.965	0.963	0.958	0.954	0.951	0.945	0.941	0.931	0.926	0.923	0.921	0.919	0.917	0.916	0.915	0.914
	0.2	1.024	1.022	1.016	1.013	1.009	1.004	1.000	0.990	0.986	0.983	0.981	0.979	0.978	0.977	0.976	0.976
	0.4	1.103	1.101	1.095	1.092	1.088	1.084	1.080	1.073	1.071	1.070	1.070	1.070	1.070	1.070	1.071	1.072
	0.6	1.107	1.105	1.100	1.097	1.094	1.090	1.087	1.082	1.081	1.082	1.083	1.085	1.086	1.087	1.089	1.091
	0.8	1.098	1.096	1.092	1.089	1.086	1.082	1.080	1.076	1.077	1.079	1.081	1.083	1.085	1.088	1.090	1.092
	1.0	1.088	1.087	1.082	1.080	1.077	1.074	1.072	1.069	1.071	1.073	1.076	1.079	1.082	1.084	1.087	1.090
	1.2	1.081	1.079	1.075	1.073	1.071	1.068	1.066	1.064	1.066	1.069	1.072	1.075	1.078	1.082	1.085	1.088
	1.4	1.075	1.074	1.070	1.068	1.066	1.063	1.062	1.060	1.063	1.066	1.070	1.073	1.077	1.080	1.084	1.087
	1.6	1.072	1.071	1.068	1.065	1.064	1.061	1.060	1.059	1.061	1.065	1.069	1.073	1.076	1.080	1.084	1.087
	1.8	1.071	1.070	1.067	1.064	1.063	1.061	1.059	1.059	1.062	1.065	1.069	1.073	1.077	1.081	1.085	1.089
	2.0	1.071	1.070	1.067	1.065	1.064	1.061	1.060	1.060	1.063	1.067	1.071	1.076	1.080	1.084	1.088	1.092

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.328	0.458	0.677	0.787	0.864	0.964	1.023	1.101	1.105	1.095	1.084	1.076	1.069	1.065	1.062	1.060
	0.02	0.327	0.457	0.676	0.785	0.862	0.962	1.021	1.099	1.103	1.093	1.083	1.074	1.068	1.064	1.061	1.059
	0.05	0.325	0.455	0.672	0.780	0.857	0.957	1.015	1.094	1.098	1.089	1.079	1.070	1.064	1.060	1.058	1.056
	0.075	0.324	0.453	0.669	0.777	0.854	0.953	1.011	1.090	1.094	1.086	1.076	1.068	1.062	1.058	1.056	1.054
	0.1	0.322	0.451	0.666	0.774	0.851	0.950	1.008	1.087	1.092	1.083	1.074	1.066	1.060	1.056	1.054	1.053
	0.15	0.320	0.448	0.662	0.770	0.846	0.944	1.003	1.082	1.087	1.079	1.070	1.063	1.057	1.054	1.052	1.050
	0.2	0.319	0.446	0.659	0.766	0.842	0.940	0.998	1.078	1.084	1.077	1.068	1.061	1.056	1.052	1.050	1.049
	0.4	0.314	0.440	0.651	0.757	0.832	0.930	0.989	1.071	1.079	1.073	1.066	1.059	1.054	1.051	1.049	1.049
	0.6	0.312	0.437	0.646	0.752	0.827	0.926	0.985	1.069	1.079	1.074	1.067	1.061	1.057	1.054	1.052	1.052
	0.8	0.310	0.434	0.643	0.749	0.824	0.922	0.982	1.069	1.080	1.076	1.070	1.064	1.060	1.057	1.056	1.055
	1.0	0.309	0.432	0.641	0.746	0.821	0.920	0.980	1.069	1.081	1.078	1.073	1.067	1.063	1.061	1.060	1.059
	1.2	0.308	0.431	0.639	0.744	0.819	0.919	0.979	1.069	1.083	1.081	1.076	1.071	1.067	1.065	1.064	1.064
	1.4	0.307	0.430	0.637	0.742	0.818	0.917	0.978	1.070	1.085	1.083	1.079	1.074	1.071	1.069	1.068	1.068
	1.6	0.306	0.429	0.636	0.741	0.816	0.916	0.977	1.071	1.087	1.086	1.082	1.078	1.075	1.073	1.072	1.072
	1.8	0.306	0.428	0.635	0.740	0.816	0.916	0.977	1.072	1.089	1.089	1.085	1.081	1.078	1.077	1.076	1.076
	2.0	0.305	0.427	0.634	0.740	0.815	0.916	0.977	1.073	1.091	1.092	1.089	1.085	1.082	1.081	1.080	1.081

Table 31: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.90$ and $r/W = 0.15$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.334	0.333	0.331	0.330	0.329	0.327	0.325	0.321	0.320	0.319	0.318	0.318	0.318	0.317	0.318	0.318
	0.02	0.467	0.466	0.463	0.461	0.459	0.457	0.455	0.450	0.447	0.446	0.445	0.445	0.444	0.444	0.445	0.445
	0.05	0.690	0.688	0.684	0.681	0.679	0.675	0.672	0.665	0.662	0.661	0.660	0.659	0.659	0.659	0.660	0.661
	0.075	0.801	0.800	0.795	0.792	0.789	0.785	0.781	0.774	0.771	0.769	0.768	0.768	0.768	0.768	0.769	0.770
	0.1	0.880	0.878	0.873	0.870	0.867	0.862	0.859	0.851	0.847	0.846	0.845	0.845	0.846	0.846	0.848	0.849
	0.15	0.982	0.980	0.975	0.971	0.968	0.963	0.959	0.951	0.949	0.948	0.948	0.948	0.949	0.950	0.952	0.954
	0.2	1.043	1.041	1.035	1.031	1.028	1.023	1.019	1.012	1.010	1.009	1.010	1.011	1.012	1.014	1.016	1.019
	0.4	1.125	1.123	1.118	1.114	1.111	1.107	1.104	1.099	1.099	1.102	1.104	1.108	1.111	1.115	1.119	1.123
	0.6	1.133	1.131	1.126	1.123	1.120	1.116	1.114	1.112	1.114	1.118	1.122	1.127	1.132	1.137	1.142	1.147
	0.8	1.128	1.126	1.122	1.119	1.116	1.113	1.111	1.110	1.114	1.119	1.125	1.131	1.137	1.143	1.149	1.155
	1.0	1.123	1.121	1.117	1.115	1.113	1.110	1.108	1.109	1.113	1.119	1.126	1.132	1.139	1.146	1.152	1.159
	1.2	1.121	1.120	1.116	1.113	1.111	1.109	1.108	1.109	1.115	1.121	1.129	1.136	1.143	1.150	1.157	1.165
	1.4	1.123	1.121	1.118	1.115	1.114	1.111	1.110	1.112	1.119	1.126	1.134	1.142	1.149	1.157	1.165	1.173
	1.6	1.128	1.126	1.123	1.121	1.119	1.117	1.116	1.119	1.126	1.134	1.142	1.151	1.159	1.167	1.175	1.184
	1.8	1.136	1.134	1.131	1.129	1.128	1.126	1.125	1.129	1.136	1.145	1.154	1.163	1.171	1.180	1.189	1.198
	2.0	1.147	1.146	1.143	1.141	1.140	1.138	1.138	1.142	1.150	1.159	1.168	1.178	1.187	1.196	1.206	1.215

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.333	0.465	0.687	0.798	0.877	0.979	1.038	1.120	1.125	1.118	1.110	1.104	1.101	1.100	1.102	1.105
	0.02	0.332	0.464	0.686	0.797	0.875	0.976	1.036	1.117	1.123	1.116	1.108	1.102	1.099	1.099	1.101	1.104
	0.05	0.330	0.461	0.682	0.792	0.870	0.971	1.031	1.112	1.118	1.112	1.104	1.099	1.096	1.096	1.097	1.101
	0.075	0.329	0.459	0.679	0.789	0.866	0.967	1.027	1.109	1.115	1.109	1.101	1.096	1.094	1.094	1.095	1.099
	0.1	0.327	0.458	0.677	0.786	0.864	0.964	1.024	1.106	1.113	1.106	1.099	1.094	1.092	1.092	1.094	1.098
	0.15	0.325	0.455	0.673	0.782	0.859	0.959	1.019	1.101	1.109	1.103	1.096	1.092	1.090	1.090	1.092	1.096
	0.2	0.324	0.453	0.670	0.778	0.855	0.956	1.015	1.098	1.106	1.101	1.095	1.091	1.089	1.089	1.091	1.096
	0.4	0.320	0.448	0.663	0.771	0.848	0.948	1.008	1.094	1.104	1.100	1.095	1.092	1.090	1.091	1.094	1.099
	0.6	0.319	0.446	0.660	0.768	0.845	0.946	1.006	1.095	1.107	1.105	1.100	1.097	1.096	1.098	1.101	1.105
	0.8	0.318	0.445	0.659	0.767	0.844	0.945	1.007	1.097	1.112	1.110	1.107	1.104	1.104	1.105	1.108	1.114
	1.0	0.318	0.444	0.659	0.767	0.844	0.946	1.008	1.101	1.117	1.117	1.114	1.112	1.111	1.113	1.117	1.122
	1.2	0.317	0.444	0.659	0.767	0.845	0.948	1.010	1.105	1.123	1.123	1.121	1.119	1.120	1.122	1.125	1.131
	1.4	0.318	0.445	0.660	0.768	0.846	0.950	1.013	1.110	1.129	1.130	1.129	1.128	1.128	1.130	1.134	1.140
	1.6	0.318	0.445	0.661	0.770	0.848	0.952	1.016	1.116	1.136	1.138	1.137	1.136	1.137	1.140	1.144	1.150
	1.8	0.319	0.447	0.663	0.772	0.851	0.956	1.021	1.122	1.143	1.146	1.146	1.146	1.147	1.149	1.154	1.160
	2.0	0.320	0.448	0.665	0.776	0.855	0.960	1.026	1.129	1.152	1.156	1.156	1.156	1.157	1.160	1.164	1.171

Table 32: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 0.90$ and $r/W = 0.20$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.343	0.342	0.340	0.339	0.337	0.335	0.334	0.332	0.331	0.331	0.331	0.332	0.333	0.334	0.336	0.338
	0.02	0.479	0.478	0.475	0.473	0.472	0.469	0.467	0.464	0.463	0.463	0.464	0.465	0.466	0.468	0.470	0.473
	0.05	0.708	0.706	0.702	0.699	0.697	0.693	0.691	0.686	0.685	0.686	0.687	0.689	0.691	0.694	0.698	0.702
	0.075	0.822	0.820	0.816	0.813	0.810	0.806	0.803	0.798	0.797	0.798	0.800	0.802	0.805	0.809	0.813	0.818
	0.1	0.903	0.901	0.896	0.893	0.890	0.886	0.882	0.877	0.877	0.878	0.881	0.884	0.887	0.891	0.896	0.902
	0.15	1.008	1.006	1.001	0.997	0.994	0.990	0.986	0.981	0.982	0.984	0.987	0.991	0.996	1.001	1.007	1.014
	0.2	1.071	1.069	1.063	1.060	1.056	1.052	1.049	1.044	1.046	1.049	1.053	1.058	1.063	1.069	1.076	1.084
c_L/r	0.4	1.161	1.158	1.153	1.149	1.147	1.143	1.140	1.139	1.143	1.150	1.157	1.164	1.172	1.181	1.190	1.200
	0.6	1.175	1.173	1.168	1.165	1.162	1.159	1.157	1.158	1.165	1.174	1.183	1.192	1.202	1.212	1.223	1.235
	0.8	1.178	1.176	1.171	1.168	1.166	1.163	1.162	1.166	1.174	1.184	1.195	1.206	1.217	1.228	1.240	1.253
	1.0	1.182	1.181	1.177	1.174	1.172	1.170	1.169	1.174	1.184	1.195	1.207	1.219	1.231	1.244	1.256	1.270
	1.2	1.193	1.191	1.187	1.185	1.183	1.181	1.181	1.187	1.198	1.211	1.224	1.237	1.250	1.263	1.277	1.291
	1.4	1.210	1.209	1.205	1.203	1.201	1.200	1.200	1.207	1.220	1.233	1.247	1.261	1.275	1.290	1.304	1.319
	1.6	1.235	1.234	1.230	1.228	1.227	1.226	1.226	1.235	1.248	1.263	1.279	1.294	1.309	1.324	1.339	1.355
	1.8	1.269	1.268	1.265	1.263	1.262	1.261	1.261	1.271	1.286	1.303	1.319	1.336	1.352	1.369	1.385	1.401
	2.0	1.315	1.314	1.311	1.309	1.308	1.307	1.308	1.319	1.336	1.354	1.373	1.391	1.409	1.426	1.444	1.461

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.340	0.475	0.701	0.815	0.895	0.999	1.061	1.146	1.155	1.152	1.148	1.148	1.152	1.159	1.171	1.188
	0.02	0.339	0.474	0.700	0.813	0.893	0.997	1.059	1.144	1.153	1.150	1.147	1.146	1.150	1.158	1.170	1.187
	0.05	0.337	0.471	0.696	0.809	0.888	0.992	1.053	1.139	1.149	1.145	1.142	1.143	1.147	1.155	1.167	1.184
	0.075	0.336	0.469	0.693	0.805	0.885	0.988	1.049	1.135	1.145	1.143	1.140	1.140	1.145	1.153	1.165	1.182
	0.1	0.334	0.467	0.691	0.803	0.882	0.985	1.046	1.132	1.143	1.141	1.138	1.139	1.143	1.151	1.164	1.181
	0.15	0.333	0.465	0.687	0.799	0.878	0.981	1.042	1.129	1.140	1.138	1.136	1.137	1.142	1.150	1.163	1.180
	0.2	0.331	0.463	0.685	0.796	0.875	0.978	1.039	1.126	1.138	1.137	1.135	1.136	1.141	1.150	1.163	1.180
c_L/r	0.4	0.329	0.460	0.681	0.791	0.870	0.973	1.035	1.126	1.140	1.140	1.140	1.142	1.148	1.157	1.170	1.188
	0.6	0.329	0.460	0.680	0.792	0.871	0.975	1.038	1.132	1.148	1.150	1.150	1.153	1.159	1.169	1.183	1.201
	0.8	0.329	0.460	0.682	0.794	0.874	0.979	1.043	1.140	1.158	1.161	1.162	1.166	1.172	1.182	1.197	1.215
	1.0	0.330	0.462	0.685	0.797	0.878	0.984	1.049	1.149	1.169	1.173	1.175	1.179	1.186	1.197	1.211	1.230
	1.2	0.332	0.465	0.689	0.802	0.883	0.991	1.057	1.160	1.182	1.187	1.190	1.194	1.202	1.213	1.227	1.247
	1.4	0.334	0.468	0.693	0.808	0.890	0.999	1.066	1.172	1.196	1.202	1.206	1.210	1.218	1.229	1.244	1.264
	1.6	0.337	0.472	0.700	0.815	0.898	1.009	1.077	1.186	1.212	1.219	1.223	1.228	1.236	1.248	1.263	1.282
	1.8	0.340	0.477	0.707	0.824	0.908	1.021	1.091	1.203	1.230	1.238	1.243	1.248	1.256	1.268	1.283	1.302
	2.0	0.345	0.483	0.716	0.835	0.921	1.035	1.106	1.222	1.251	1.260	1.265	1.271	1.279	1.291	1.306	1.325

Table 33: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 1.00$ and $r/W = 0.05$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.325	0.324	0.322	0.321	0.319	0.317	0.316	0.311	0.308	0.306	0.304	0.302	0.301	0.299	0.298	0.297
	0.02	0.454	0.453	0.450	0.448	0.447	0.444	0.441	0.435	0.431	0.428	0.425	0.423	0.421	0.419	0.417	0.416
	0.05	0.671	0.670	0.666	0.663	0.660	0.656	0.653	0.644	0.638	0.634	0.630	0.627	0.624	0.622	0.619	0.617
	0.075	0.780	0.778	0.773	0.770	0.767	0.762	0.759	0.749	0.742	0.738	0.734	0.730	0.727	0.725	0.722	0.720
	0.1	0.856	0.854	0.849	0.846	0.843	0.838	0.833	0.823	0.816	0.812	0.808	0.804	0.801	0.798	0.795	0.793
	0.15	0.955	0.953	0.948	0.944	0.941	0.935	0.931	0.920	0.914	0.909	0.905	0.902	0.898	0.896	0.893	0.891
	0.2	1.013	1.011	1.006	1.002	0.998	0.993	0.988	0.978	0.972	0.967	0.964	0.961	0.958	0.955	0.953	0.950
	0.4	1.090	1.088	1.083	1.079	1.076	1.070	1.067	1.058	1.054	1.051	1.049	1.048	1.046	1.045	1.043	1.042
	0.6	1.092	1.090	1.085	1.082	1.079	1.075	1.071	1.065	1.062	1.061	1.061	1.060	1.059	1.059	1.058	1.058
	0.8	1.081	1.080	1.075	1.072	1.069	1.065	1.063	1.057	1.056	1.056	1.056	1.056	1.056	1.056	1.056	1.056
	1.0	1.070	1.068	1.064	1.061	1.059	1.055	1.053	1.048	1.048	1.048	1.049	1.049	1.050	1.050	1.051	1.051
	1.2	1.060	1.058	1.054	1.052	1.050	1.046	1.044	1.040	1.040	1.041	1.042	1.043	1.043	1.044	1.045	1.045
	1.4	1.052	1.050	1.047	1.044	1.042	1.039	1.037	1.034	1.034	1.035	1.036	1.037	1.038	1.039	1.040	1.041
	1.6	1.046	1.044	1.041	1.039	1.037	1.034	1.032	1.029	1.029	1.030	1.032	1.033	1.034	1.035	1.036	1.037
	1.8	1.041	1.040	1.036	1.034	1.033	1.030	1.028	1.025	1.026	1.027	1.028	1.030	1.031	1.032	1.033	1.034
	2.0	1.037	1.036	1.033	1.031	1.029	1.027	1.025	1.023	1.023	1.024	1.026	1.027	1.028	1.030	1.031	1.032

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
c_L/r	0.01	0.325	0.454	0.671	0.780	0.856	0.955	1.013	1.090	1.092	1.081	1.070	1.060	1.052	1.046	1.041	1.037
	0.02	0.324	0.453	0.670	0.778	0.854	0.953	1.011	1.088	1.090	1.080	1.068	1.058	1.050	1.044	1.040	1.036
	0.05	0.322	0.450	0.666	0.773	0.849	0.948	1.006	1.083	1.086	1.075	1.064	1.054	1.047	1.041	1.036	1.033
	0.075	0.321	0.448	0.663	0.770	0.846	0.944	1.002	1.079	1.082	1.072	1.061	1.052	1.044	1.039	1.034	1.031
	0.1	0.319	0.447	0.660	0.767	0.843	0.941	0.998	1.076	1.079	1.070	1.059	1.050	1.042	1.037	1.033	1.029
	0.15	0.317	0.444	0.656	0.762	0.838	0.935	0.993	1.070	1.075	1.066	1.055	1.046	1.039	1.034	1.030	1.027
	0.2	0.316	0.441	0.653	0.759	0.833	0.931	0.988	1.067	1.071	1.063	1.053	1.044	1.037	1.032	1.028	1.025
	0.4	0.311	0.435	0.644	0.749	0.823	0.920	0.978	1.058	1.065	1.057	1.048	1.040	1.034	1.029	1.025	1.023
	0.6	0.308	0.431	0.638	0.742	0.816	0.913	0.972	1.054	1.062	1.056	1.048	1.040	1.034	1.029	1.026	1.023
	0.8	0.306	0.428	0.634	0.738	0.812	0.909	0.967	1.051	1.061	1.056	1.048	1.041	1.035	1.030	1.027	1.024
	1.0	0.304	0.425	0.630	0.734	0.808	0.905	0.964	1.049	1.061	1.056	1.049	1.042	1.036	1.032	1.028	1.026
	1.2	0.302	0.423	0.627	0.730	0.804	0.902	0.961	1.048	1.060	1.056	1.049	1.043	1.037	1.033	1.030	1.027
	1.4	0.301	0.421	0.624	0.727	0.801	0.898	0.958	1.046	1.059	1.056	1.050	1.043	1.038	1.034	1.031	1.028
	1.6	0.299	0.419	0.622	0.725	0.798	0.896	0.955	1.045	1.059	1.056	1.050	1.044	1.039	1.035	1.032	1.030
	1.8	0.298	0.417	0.619	0.722	0.795	0.893	0.953	1.043	1.058	1.056	1.051	1.045	1.040	1.036	1.033	1.031
	2.0	0.297	0.416	0.617	0.720	0.793	0.891	0.950	1.042	1.058	1.056	1.051	1.045	1.041	1.037	1.034	1.032

Table 34: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 1.00$ and $r/W = 0.10$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.328	0.327	0.325	0.324	0.322	0.320	0.319	0.314	0.312	0.310	0.309	0.307	0.307	0.306	0.305	0.304
	0.02	0.458	0.457	0.455	0.453	0.451	0.448	0.446	0.440	0.436	0.434	0.432	0.430	0.429	0.428	0.427	0.426
	0.05	0.677	0.676	0.672	0.669	0.666	0.662	0.659	0.651	0.646	0.643	0.640	0.638	0.636	0.635	0.634	0.633
	0.075	0.787	0.785	0.780	0.777	0.774	0.770	0.766	0.757	0.752	0.748	0.745	0.743	0.741	0.740	0.739	0.738
	0.1	0.864	0.862	0.857	0.854	0.851	0.846	0.842	0.832	0.827	0.823	0.821	0.818	0.816	0.815	0.814	0.813
	0.15	0.964	0.962	0.957	0.953	0.950	0.944	0.940	0.930	0.925	0.922	0.919	0.918	0.916	0.915	0.914	0.913
	0.2	1.023	1.021	1.015	1.011	1.008	1.002	0.998	0.989	0.984	0.981	0.979	0.978	0.977	0.976	0.975	0.975
c_L/r	0.4	1.101	1.099	1.094	1.090	1.087	1.082	1.078	1.071	1.069	1.068	1.068	1.068	1.068	1.069	1.069	1.070
	0.6	1.105	1.103	1.098	1.095	1.092	1.088	1.085	1.079	1.079	1.080	1.081	1.082	1.084	1.085	1.087	1.089
	0.8	1.095	1.094	1.089	1.086	1.084	1.080	1.077	1.074	1.074	1.076	1.078	1.080	1.082	1.085	1.087	1.089
	1.0	1.085	1.083	1.079	1.077	1.074	1.071	1.069	1.066	1.067	1.070	1.072	1.075	1.078	1.081	1.083	1.086
	1.2	1.077	1.075	1.072	1.069	1.067	1.064	1.062	1.060	1.062	1.065	1.068	1.071	1.074	1.077	1.080	1.083
	1.4	1.071	1.069	1.066	1.064	1.062	1.059	1.057	1.056	1.058	1.061	1.064	1.068	1.071	1.074	1.078	1.081
	1.6	1.067	1.066	1.062	1.060	1.058	1.056	1.054	1.053	1.055	1.059	1.062	1.066	1.070	1.073	1.077	1.080
	1.8	1.065	1.063	1.060	1.058	1.056	1.054	1.053	1.052	1.055	1.058	1.062	1.066	1.069	1.073	1.077	1.081
	2.0	1.064	1.062	1.060	1.058	1.056	1.054	1.053	1.052	1.055	1.059	1.062	1.066	1.070	1.074	1.078	1.082

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.328	0.458	0.677	0.787	0.864	0.964	1.023	1.101	1.105	1.095	1.085	1.077	1.071	1.067	1.065	1.064
	0.02	0.327	0.457	0.676	0.785	0.862	0.962	1.021	1.099	1.103	1.094	1.083	1.075	1.069	1.066	1.063	1.062
	0.05	0.325	0.455	0.672	0.780	0.857	0.957	1.015	1.094	1.098	1.089	1.079	1.072	1.066	1.062	1.060	1.060
	0.075	0.324	0.453	0.669	0.777	0.854	0.953	1.011	1.090	1.095	1.086	1.077	1.069	1.064	1.060	1.058	1.058
	0.1	0.322	0.451	0.666	0.774	0.851	0.950	1.008	1.087	1.092	1.084	1.074	1.067	1.062	1.058	1.056	1.056
	0.15	0.320	0.448	0.662	0.770	0.846	0.944	1.002	1.082	1.088	1.080	1.071	1.064	1.059	1.056	1.054	1.054
	0.2	0.319	0.446	0.659	0.766	0.842	0.940	0.998	1.078	1.085	1.077	1.069	1.062	1.057	1.054	1.053	1.053
c_L/r	0.4	0.314	0.440	0.651	0.757	0.832	0.930	0.989	1.071	1.079	1.074	1.066	1.060	1.056	1.053	1.052	1.052
	0.6	0.312	0.436	0.646	0.752	0.827	0.925	0.984	1.069	1.079	1.074	1.067	1.062	1.058	1.056	1.055	1.055
	0.8	0.310	0.434	0.643	0.748	0.823	0.922	0.981	1.068	1.080	1.076	1.070	1.065	1.061	1.059	1.058	1.059
	1.0	0.309	0.432	0.640	0.746	0.821	0.919	0.979	1.068	1.081	1.078	1.072	1.068	1.064	1.062	1.062	1.062
	1.2	0.308	0.430	0.638	0.743	0.818	0.917	0.978	1.068	1.082	1.080	1.075	1.071	1.068	1.066	1.066	1.066
	1.4	0.307	0.429	0.636	0.741	0.817	0.916	0.977	1.068	1.084	1.082	1.078	1.074	1.071	1.070	1.069	1.070
	1.6	0.306	0.428	0.635	0.740	0.815	0.915	0.976	1.069	1.085	1.085	1.081	1.077	1.074	1.073	1.073	1.074
	1.8	0.305	0.427	0.634	0.739	0.814	0.914	0.975	1.069	1.087	1.087	1.083	1.080	1.078	1.077	1.077	1.078
	2.0	0.304	0.426	0.633	0.738	0.813	0.913	0.975	1.070	1.089	1.089	1.086	1.083	1.081	1.080	1.081	1.082

Table 35: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 1.00$ and $r/W = 0.15$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.333	0.332	0.330	0.329	0.327	0.325	0.324	0.320	0.319	0.318	0.317	0.317	0.317	0.317	0.317	0.318
	0.02	0.465	0.464	0.461	0.460	0.458	0.455	0.453	0.448	0.446	0.444	0.444	0.443	0.443	0.443	0.444	0.445
	0.05	0.688	0.686	0.682	0.679	0.677	0.673	0.670	0.663	0.660	0.658	0.657	0.657	0.657	0.658	0.659	0.660
	0.075	0.799	0.797	0.792	0.789	0.786	0.782	0.779	0.771	0.768	0.766	0.765	0.765	0.766	0.766	0.768	0.770
	0.1	0.877	0.875	0.870	0.867	0.864	0.859	0.856	0.848	0.845	0.843	0.843	0.843	0.843	0.844	0.846	0.848
	0.15	0.979	0.977	0.972	0.968	0.965	0.960	0.956	0.948	0.945	0.944	0.944	0.945	0.946	0.948	0.950	0.953
	0.2	1.039	1.037	1.031	1.028	1.024	1.019	1.015	1.008	1.006	1.006	1.006	1.007	1.009	1.012	1.014	1.018
c_L/r	0.4	1.121	1.119	1.113	1.110	1.107	1.102	1.099	1.094	1.094	1.097	1.100	1.103	1.107	1.111	1.115	1.120
	0.6	1.127	1.125	1.120	1.117	1.114	1.110	1.108	1.105	1.108	1.111	1.116	1.121	1.126	1.131	1.137	1.143
	0.8	1.120	1.119	1.114	1.111	1.109	1.105	1.103	1.102	1.106	1.111	1.117	1.122	1.128	1.135	1.141	1.148
	1.0	1.114	1.112	1.108	1.105	1.103	1.100	1.098	1.099	1.103	1.109	1.115	1.122	1.128	1.135	1.142	1.150
	1.2	1.109	1.108	1.104	1.101	1.100	1.097	1.096	1.097	1.102	1.108	1.115	1.122	1.129	1.136	1.144	1.152
	1.4	1.108	1.107	1.103	1.101	1.099	1.097	1.095	1.097	1.103	1.110	1.117	1.124	1.132	1.140	1.148	1.156
	1.6	1.109	1.108	1.105	1.103	1.101	1.099	1.098	1.100	1.106	1.114	1.121	1.129	1.137	1.145	1.153	1.162
	1.8	1.114	1.112	1.109	1.107	1.106	1.104	1.103	1.106	1.112	1.120	1.128	1.136	1.144	1.153	1.161	1.170
	2.0	1.120	1.119	1.116	1.114	1.113	1.111	1.110	1.114	1.120	1.128	1.137	1.145	1.154	1.162	1.171	1.180

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.333	0.465	0.688	0.799	0.877	0.979	1.039	1.121	1.127	1.120	1.114	1.109	1.108	1.109	1.114	1.120
	0.02	0.332	0.464	0.686	0.797	0.875	0.977	1.037	1.119	1.125	1.119	1.112	1.108	1.107	1.108	1.112	1.119
	0.05	0.330	0.461	0.682	0.792	0.870	0.972	1.031	1.113	1.120	1.114	1.108	1.104	1.103	1.105	1.109	1.116
	0.075	0.329	0.460	0.679	0.789	0.867	0.968	1.028	1.110	1.117	1.111	1.105	1.101	1.101	1.103	1.107	1.114
	0.1	0.327	0.458	0.677	0.786	0.864	0.965	1.024	1.107	1.114	1.109	1.103	1.100	1.099	1.101	1.106	1.113
	0.15	0.325	0.455	0.673	0.782	0.859	0.960	1.019	1.102	1.110	1.105	1.100	1.097	1.097	1.099	1.104	1.111
	0.2	0.324	0.453	0.670	0.779	0.856	0.956	1.015	1.099	1.108	1.103	1.098	1.096	1.095	1.098	1.103	1.110
c_L/r	0.4	0.320	0.448	0.663	0.771	0.848	0.948	1.008	1.094	1.105	1.102	1.099	1.097	1.097	1.100	1.106	1.114
	0.6	0.319	0.446	0.660	0.768	0.845	0.945	1.006	1.094	1.108	1.106	1.103	1.102	1.103	1.106	1.112	1.120
	0.8	0.318	0.444	0.658	0.766	0.843	0.944	1.006	1.097	1.111	1.111	1.109	1.108	1.110	1.114	1.120	1.128
	1.0	0.317	0.444	0.657	0.765	0.843	0.944	1.006	1.100	1.116	1.117	1.115	1.115	1.117	1.121	1.128	1.137
	1.2	0.317	0.443	0.657	0.765	0.843	0.945	1.008	1.103	1.121	1.122	1.122	1.122	1.124	1.129	1.136	1.145
	1.4	0.317	0.443	0.657	0.766	0.843	0.946	1.009	1.107	1.126	1.128	1.128	1.129	1.132	1.137	1.144	1.154
	1.6	0.317	0.443	0.658	0.766	0.844	0.948	1.012	1.111	1.131	1.135	1.135	1.136	1.140	1.145	1.153	1.162
	1.8	0.317	0.444	0.659	0.768	0.846	0.950	1.014	1.115	1.137	1.141	1.142	1.144	1.148	1.153	1.161	1.171
	2.0	0.318	0.445	0.660	0.770	0.848	0.953	1.018	1.120	1.143	1.148	1.150	1.152	1.156	1.162	1.170	1.180

Table 36: *Beta factors F_{aL} and F_{aR} for the left-hand and right-hand collinear cracks emanating from an offset circular hole in a rectangular plate subjected to a remote uniform tension stress. Results for plate and hole geometry parameters $H/W = 4.00$, $d/W = 1.00$ and $r/W = 0.20$.*

F_{aL}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.340	0.339	0.337	0.336	0.335	0.333	0.332	0.329	0.328	0.329	0.329	0.330	0.332	0.333	0.336	0.338
	0.02	0.476	0.475	0.472	0.470	0.468	0.466	0.464	0.460	0.459	0.460	0.461	0.462	0.464	0.467	0.470	0.474
	0.05	0.703	0.701	0.697	0.694	0.692	0.688	0.686	0.681	0.680	0.681	0.683	0.685	0.688	0.692	0.697	0.703
	0.075	0.816	0.815	0.810	0.807	0.804	0.800	0.797	0.792	0.791	0.793	0.795	0.798	0.802	0.807	0.812	0.819
	0.1	0.897	0.895	0.890	0.886	0.884	0.879	0.876	0.871	0.870	0.872	0.875	0.879	0.883	0.889	0.895	0.903
	0.15	1.001	0.999	0.994	0.990	0.987	0.982	0.979	0.974	0.975	0.977	0.981	0.986	0.991	0.998	1.006	1.015
	0.2	1.063	1.061	1.055	1.052	1.048	1.044	1.041	1.036	1.038	1.041	1.046	1.051	1.058	1.066	1.075	1.085
c_L/r	0.4	1.150	1.148	1.142	1.139	1.136	1.132	1.129	1.128	1.133	1.139	1.147	1.155	1.164	1.174	1.186	1.199
	0.6	1.161	1.159	1.154	1.151	1.148	1.145	1.143	1.144	1.151	1.159	1.169	1.179	1.190	1.201	1.214	1.229
	0.8	1.160	1.158	1.153	1.150	1.148	1.145	1.144	1.147	1.155	1.165	1.176	1.187	1.199	1.212	1.226	1.241
	1.0	1.159	1.158	1.154	1.151	1.149	1.147	1.146	1.150	1.159	1.170	1.182	1.194	1.207	1.220	1.235	1.251
	1.2	1.163	1.162	1.158	1.156	1.154	1.152	1.151	1.156	1.167	1.178	1.191	1.203	1.217	1.231	1.246	1.262
	1.4	1.172	1.171	1.167	1.165	1.164	1.162	1.161	1.168	1.179	1.191	1.204	1.217	1.231	1.246	1.261	1.278
	1.6	1.187	1.185	1.182	1.180	1.178	1.177	1.177	1.184	1.196	1.209	1.222	1.236	1.251	1.266	1.282	1.299
	1.8	1.207	1.206	1.202	1.200	1.199	1.198	1.198	1.206	1.218	1.232	1.247	1.261	1.276	1.292	1.308	1.325
	2.0	1.234	1.233	1.230	1.228	1.227	1.226	1.226	1.235	1.248	1.263	1.278	1.293	1.309	1.325	1.342	1.359

F_{aR}		c_R/r															
		0.01	0.02	0.05	0.075	0.1	0.15	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
	0.01	0.340	0.476	0.703	0.816	0.897	1.001	1.063	1.150	1.161	1.160	1.159	1.163	1.172	1.187	1.207	1.234
	0.02	0.339	0.475	0.701	0.815	0.895	0.999	1.061	1.148	1.159	1.158	1.158	1.162	1.171	1.185	1.206	1.233
	0.05	0.338	0.472	0.697	0.810	0.890	0.994	1.055	1.142	1.154	1.153	1.154	1.158	1.167	1.182	1.202	1.230
	0.075	0.336	0.470	0.694	0.807	0.886	0.990	1.052	1.139	1.151	1.150	1.151	1.156	1.165	1.180	1.200	1.228
	0.1	0.335	0.468	0.692	0.804	0.884	0.987	1.048	1.136	1.148	1.148	1.149	1.154	1.164	1.178	1.199	1.227
	0.15	0.333	0.466	0.689	0.800	0.879	0.982	1.044	1.132	1.145	1.145	1.147	1.152	1.162	1.177	1.198	1.226
	0.2	0.332	0.464	0.686	0.797	0.876	0.979	1.041	1.129	1.143	1.144	1.146	1.151	1.161	1.177	1.198	1.226
c_L/r	0.4	0.329	0.460	0.681	0.792	0.871	0.974	1.036	1.128	1.144	1.147	1.150	1.156	1.168	1.184	1.206	1.235
	0.6	0.328	0.460	0.680	0.791	0.870	0.975	1.038	1.133	1.151	1.155	1.159	1.167	1.179	1.196	1.218	1.248
	0.8	0.329	0.460	0.681	0.793	0.872	0.977	1.041	1.139	1.159	1.165	1.170	1.178	1.191	1.209	1.232	1.263
	1.0	0.329	0.461	0.683	0.795	0.875	0.981	1.046	1.147	1.169	1.176	1.182	1.191	1.204	1.222	1.247	1.278
	1.2	0.330	0.462	0.685	0.798	0.879	0.986	1.051	1.155	1.179	1.187	1.194	1.203	1.217	1.236	1.261	1.293
	1.4	0.332	0.464	0.688	0.802	0.883	0.991	1.058	1.164	1.190	1.199	1.207	1.217	1.231	1.251	1.276	1.309
	1.6	0.333	0.467	0.692	0.807	0.889	0.998	1.066	1.174	1.201	1.212	1.220	1.231	1.246	1.266	1.292	1.325
	1.8	0.336	0.470	0.697	0.812	0.895	1.006	1.074	1.186	1.214	1.226	1.235	1.246	1.261	1.282	1.308	1.342
	2.0	0.338	0.474	0.703	0.819	0.903	1.015	1.085	1.199	1.229	1.241	1.251	1.262	1.278	1.299	1.325	1.359

Appendix A: MFADD input file for two cracks emanating from an offset circular hole in a finite plate subjected to a remote uniform tensile load

```
FADD - Visual C++ Version 1.0 - 11/20/12
Two unequal cracks from a hole in a uniaxially loaded plate

-------------------------------------------------------
Problem Type, No of Materials
2 1
Materials, Elastic modulus, and Poisson's ratio
1 10000.000000 0.300000
Material, Cracks, Boundaries, and Point loads
1 2 2 0
Crack-growth steps, increment, and Paris law exponent
0 1.000000 3.000000
 Input echo, Boundary Stresses, and Displacements
1 1 1

-------------------------------------------------------
Definition of Crack

1 1
1 0 0 2 1
1 1 -10.000000 0.000000 -11.000000 0.000000 12

2 1
1 0 0 2 1
1 1  10.000000 0.000000  11.000000 0.000000 12

-------------------------------------------------------
Definition of Boundary

1 1
0 0 10

1 1 8
20.000000 0.000000 -1 0.000000  0 0.000000 0
20.000000 1.000000 -1 0.000000 -1 0.000000 0
20.000000 2.000000 -1 0.000000 -1 0.000000 0

2 1 8
20.000000  2.000000 -1 0.000000 -1 0.000000 0
20.000000 41.000000 -1 0.000000 -1 0.000000 0
20.000000 80.000000 -1 0.000000 -1 0.000000 0

3 1 8
 20.000000 80.000000 -1 0.000000 -1 100.000000 0
  0.000000 80.000000 -1 0.000000 -1 100.000000 0
-20.000000 80.000000 -1 0.000000 -1 100.000000 0

4 1 8
-20.000000 80.000000 -1 0.000000 -1 0.000000 0
-20.000000 41.000000 -1 0.000000 -1 0.000000 0
-20.000000  2.000000 -1 0.000000 -1 0.000000 0
```

```
5 1 8
-20.000000 2.000000 -1 0.000000 -1 0.000000 0
-20.000000 1.000000 -1 0.000000 -1 0.000000 0
-20.000000 0.000000  0 0.000000  0 0.000000 0

6 1 8
-20.000000  0.000000  0 0.000000  0 0.000000 0
-20.000000 -1.000000 -1 0.000000 -1 0.000000 0
-20.000000 -2.000000 -1 0.000000 -1 0.000000 0

7 1 8
-20.000000  -2.000000 -1 0.000000 -1 0.000000 0
-20.000000 -41.000000 -1 0.000000 -1 0.000000 0
-20.000000 -80.000000 -1 0.000000 -1 0.000000 0

8 1 8
-20.000000 -80.000000 -1 0.000000 -1 -100.000000 0
  0.000000 -80.000000 -1 0.000000 -1 -100.000000 0
 20.000000 -80.000000 -1 0.000000 -1 -100.000000 0

9 1 8
20.000000 -80.000000 -1 0.000000 -1 0.000000 0
20.000000 -41.000000 -1 0.000000 -1 0.000000 0
20.000000  -2.000000 -1 0.000000 -1 0.000000 0

10 1 8
20.000000 -2.000000 -1 0.000000 -1 0.000000 0
20.000000 -1.000000 -1 0.000000 -1 0.000000 0
20.000000  0.000000 -1 0.000000  0 0.000000 0

2 1
2 0 10

1 0 0.000000 0.000000 10.000000 12
180.000000 -1 0.000000 -1 0.000000 1
175.000000 -1 0.000000 -1 0.000000 0
170.000000 -1 0.000000 -1 0.000000 0

2 0 0.000000 0.000000 10.000000 4
170.000000 -1 0.000000 -1 0.000000 0
152.500000 -1 0.000000 -1 0.000000 0
135.000000 -1 0.000000 -1 0.000000 0

3 0 0.000000 0.000000 10.000000 4
135.000000 -1 0.000000 -1 0.000000 0
 90.000000 -1 0.000000 -1 0.000000 0
 45.000000 -1 0.000000 -1 0.000000 0

4 0 0.000000 0.000000 10.000000 4
45.000000 -1 0.000000 -1 0.000000 0
27.500000 -1 0.000000 -1 0.000000 0
10.000000 -1 0.000000 -1 0.000000 0

5 0 0.000000 0.000000 10.000000 12
10.000000 -1 0.000000 -1 0.000000 0
 5.000000 -1 0.000000 -1 0.000000 0
 0.000000 -1 0.000000 -1 0.000000 2
```

```
6 0 0.000000 0.000000 10.000000 12
  0.000000 -1 0.000000 -1 0.000000 2
 -5.000000 -1 0.000000 -1 0.000000 0
-10.000000 -1 0.000000 -1 0.000000 0

7 0 0.000000 0.000000 10.000000 4
-10.000000 -1 0.000000 -1 0.000000 0
-27.500000 -1 0.000000 -1 0.000000 0
-45.000000 -1 0.000000 -1 0.000000 0

8 0 0.000000 0.000000 10.000000 4
 -45.000000 -1 0.000000 -1 0.000000 0
 -90.000000 -1 0.000000 -1 0.000000 0
-135.000000 -1 0.000000 -1 0.000000 0

9 0 0.000000 0.000000 10.000000 4
-135.000000 -1 0.000000 -1 0.000000 0
-152.500000 -1 0.000000 -1 0.000000 0
-170.000000 -1 0.000000 -1 0.000000 0

10 0 0.000000 0.000000 10.000000 12
-170.000000 -1 0.000000 -1 0.000000 0
-175.000000 -1 0.000000 -1 0.000000 0
-180.000000 -1 0.000000 -1 0.000000 1

-------------------------------------------------------
```

Appendix B: MFADD input file for two cracks emanating from a circular hole in an infinite plate subject to a remote uniform tensile load

```
FADD - Visual C++ Version 1.0 - 08/13/12
Two cracks from hole in infinite plate under uniform stress

-------------------------------------------------------
Problem Type, No of Materials
3 1
Material, SigXX, SigYY, SigXY, Zx, Zy,
1 0.000000 100.000000 0.000000 0.000000 0.000000
Materials, Elastic modulus, and Poisson's ratio
1 10000.000000 0.300000
Material, Cracks, Boundaries, and Point loads
1 2 1 0
Crack-growth steps, increment, and Paris law exponent
0 0.250000 3.000000
 Input echo, Boundary Stresses, and Displacements
1 1 1

-------------------------------------------------------
Definition of Crack

1 1
1 0 0 2 1
1 1 -10.000000 0.000000 -11.000000 0.000000 22

2 1
1 0 0 2 1
1 1  10.000000 0.000000  11.000000 0.000000 22

-------------------------------------------------------
Definition of Boundary

1 1
2 0 10

1 0 0.000000 0.000000 10.000000 16
180.000000 -1 0.000000 -1 0.000000 1
175.000000 -1 0.000000 -1 0.000000 0
170.000000 -1 0.000000 -1 0.000000 0

2 0 0.000000 0.000000 10.000000 4
170.000000 -1 0.000000 -1 0.000000 0
152.500000 -1 0.000000 -1 0.000000 0
135.000000 -1 0.000000 -1 0.000000 0

3 0 0.000000 0.000000 10.000000 6
135.000000 -1 0.000000 -1 0.000000 0
 90.000000 -1 0.000000 -1 0.000000 0
 45.000000 -1 0.000000 -1 0.000000 0

4 0 0.000000 0.000000 10.000000 4
45.000000 -1 0.000000 -1 0.000000 0
```

```
27.500000 -1 0.000000 -1 0.000000 0
10.000000 -1 0.000000 -1 0.000000 0

5 0 0.000000 0.000000 10.000000 16
10.000000 -1 0.000000 -1 0.000000 0
 5.000000 -1 0.000000 -1 0.000000 0
 0.000000 -1 0.000000 -1 0.000000 2

6 0 0.000000 0.000000 10.000000 16
  0.000000 -1 0.000000 -1 0.000000 2
 -5.000000 -1 0.000000 -1 0.000000 0
-10.000000 -1 0.000000 -1 0.000000 0

7 0 0.000000 0.000000 10.000000 4
-10.000000 -1 0.000000 -1 0.000000 0
-27.500000 -1 0.000000 -1 0.000000 0
-45.000000 -1 0.000000 -1 0.000000 0

8 0 0.000000 0.000000 10.000000 6
 -45.000000 -1 0.000000 -1 0.000000 0
 -90.000000 -1 0.000000 -1 0.000000 0
-135.000000 -1 0.000000 -1 0.000000 0

9 0 0.000000 0.000000 10.000000 4
-135.000000 -1 0.000000 -1 0.000000 0
-152.500000 -1 0.000000 -1 0.000000 0
-170.000000 -1 0.000000 -1 0.000000 0

10 0 0.000000 0.000000 10.000000 16
-170.000000 -1 0.000000 -1 0.000000 0
-175.000000 -1 0.000000 -1 0.000000 0
-180.000000 -1 0.000000 -1 0.000000 1

-------------------------------------------------------
```

Appendix C: FORTRAN 90 source code for RunMFADD program

```
!==============================================================================

program RunMFADD

! This program illustrates the use of the MFADD.EXE program to compute
! boundary element solutions to crack problems. A number of test cases
! taken from the literature are used as points of comparison with
! the method of fracture analysis by distributed dislocations that is
! implemented in MFADD.EXE.

integer   ichoice
character ofn*120

ichoice = 1

do while (ichoice /= 0)
  write(*,'(a)') &
  '==================================================================='
  write(*,'(a)') &
  '    Solution of crack problems using FADD2D boundary element code'
  write(*,'(a)') &
  '==================================================================='
  write(*,'(a)')
  write(*,'(a)') &
  ' 1 Compute solutions to Rooke and Tweed test cases'
  write(*,'(a)') &
  ' 2 Compute solutions to Nisitani and Isida test cases'
  write(*,'(a)') &
  ' 3 Compute solutions to Isida and Nakamura test cases'
  write(*,'(a)') &
  ' 4 Compute solutions to Murakami test cases'
  write(*,'(a)') &
  ' 5 Compute closed-form equal-crack infinite plate solutions'
  write(*,'(a)') &
  ' 6 Compute closed-form equal-crack infinite strip solutions'
  write(*,'(a)') &
  ' 7 Compute closed-form unequal-crack infinite plate solutions'
  write(*,'(a)') &
  ' 8 Compute solutions to some other test cases'
  write(*,'(a)') &
  ' 9 Compute solutions to StressCheck offset hole test cases'
  write(*,'(a)') &
  '10 Compute solutions for asymmetric cracks with plate width effects'
  write(*,'(a)') &
  '11 Compute solutions for varying hole offsets and crack lengths'
  write(*,'(a)')
  write(*,'(a)') &
  ' 0 Exit'
  write(*,'(a)')
  write(*,'(a)',ADVANCE='NO') &
  'Input choice: '
  read(*,*) ichoice
  write(*,'(a)')
  select case (ichoice)
    case (1)
      ofn = 'PlateTestRookeTweed.out'
      call TestRookeTweed(ofn)
    case (2)
      ofn = 'PlateTestNisitaniIsida.out'
      call TestNisitaniIsida(ofn)
    case (3)
      ofn = 'PlateTestIsidaNakamura.out'
```

```
      call TestIsidaNakamura(ofn)
    case (4)
      ofn = 'PlateTestMurakami.out'
      call TestMurakami(ofn)
    case (5)
      ofn = 'PlateTestAnalyticalEqualCracksIP.out'
      call TestAnalyticalEqualCracksIP(ofn)
    case (6)
      ofn = 'PlateTestAnalyticalEqualCracksIS.out'
      call TestAnalyticalEqualCracksIS(ofn)
    case (7)
      ofn = 'PlateTestAnalyticalUnequalCracksIP.out'
      call TestAnalyticalUnequalCracksIP(ofn)
    case (8)
      ofn = 'PlateTestOtherCases.out'
      call TestOtherCases(ofn)
    case (9)
      ofn = 'PlateTestStressCheck.out'
      call TestStressCheck(ofn)
    case (10)
      ofn = 'PlateTestAnalyticalCracks.out'
      call TestAnalyticalCracks(ofn)
    case (11)
      ofn = 'PlateTables.out'
      call CreateTables(ofn)
  end select
  if (ichoice /= 0) then
    write(*,'(a)') &
    'Results have been written to the file "'//ofn(1:len_trim(ofn))//'".'
    write(*,'(a)') &
    'If a prior version of this file existed, then it was overwritten.'
  end if
  write(*,'(a)')
end do

end program RunMFADD

!================================================================================

subroutine TestOtherCases(ofn)

implicit none

character ofn*(*)

real*8    clonr,cronr,donw,ronw,fal,far,fcl,fcr,faavg,fcavg,aonw,honw
real*8    etime0,etime1,etime
integer   i,ierror,count,lun
logical   deleteinfile,deleteoutfiles

real*8    timef

open(unit=7,file=ofn,status='unknown')

deleteinfile   = .true.
deleteoutfiles = .true.

write(*,'(a)') 'Test Case 1: Started computing the Beta factors.'
write(*,*)

ronw   = 0.50d0
honw   = 2.00d0
donw   = 1.00d0
count  = 0
etime0 = timef()
do lun = 6,7
  write(lun,'(a,f12.6)') 'r/w= ',ronw
  write(lun,'(a,f12.6)') 'h/w= ',honw
```

```
  write(lun,'(a,f12.6)') 'd/w= ',donw
  write(lun,*)
  write(lun,'(8a12)') 'a/w','FA_L','FA_R','FA_avg','FC_L','FC_R','FC_avg','ierror'
enddo
do i = 505,900,5
  count = count+1
  aonw  = i/1000.0d0
  clonr = aonw/ronw-1.0d0
  cronr = clonr
  call UCOCHFPUT(honw,donw,ronw,clonr,cronr,fal,far,fcl,fcr,ierror, &
                 deleteinfile,deleteoutfiles)
  faavg = (fal+far)/2.0d0
  fcavg = (fcl+fcr)/2.0d0
  do lun = 6,7
    write(lun,'(7f12.6,i12)') aonw,fal,far,faavg,fcl,fcr,fcavg,ierror
  end do
end do
etime1 = timef()
etime  = etime1-etime0
do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
  write(lun,*)
enddo

write(*,'(a)') 'Test Case 2: Started computing the Beta factors.'
write(*,*)

ronw   = 0.25d0
honw   = 2.00d0
donw   = 1.00d0
count  = 0
etime0 = timef()
do lun = 6,7
  write(lun,'(a,f12.6)') 'r/w= ',ronw
  write(lun,'(a,f12.6)') 'h/w= ',honw
  write(lun,'(a,f12.6)') 'd/w= ',donw
  write(lun,*)
  write(lun,'(8a12)') 'a/w','FA_L','FA_R','FA_avg','FC_L','FC_R','FC_avg','ierror'
end do
do i = 255,900,5
  count = count+1
  aonw  = i/1000.0d0
  clonr = aonw/ronw-1.0d0
  cronr = clonr
  call UCOCHFPUT(honw,donw,ronw,clonr,cronr,fal,far,fcl,fcr,ierror, &
                 deleteinfile,deleteoutfiles)
  faavg = (fal+far)/2.0d0
  fcavg = (fcl+fcr)/2.0d0
  do lun = 6,7
    write(lun,'(7f12.6,i12)') aonw,fal,far,faavg,fcl,fcr,fcavg,ierror
  end do
end do
etime1 = timef()
etime  = etime1-etime0
do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
  write(lun,*)
end do

write(*,'(a)') 'Test Case 3: Started computing the Beta factors.'
write(*,*)

ronw   = 0.10d0
honw   = 2.00d0
```

```
donw   = 1.00d0
count  = 0
etime0 = timef()
do lun = 6,7
  write(lun,'(a,f12.6)') 'r/w= ',ronw
  write(lun,'(a,f12.6)') 'h/w= ',honw
  write(lun,'(a,f12.6)') 'd/w= ',donw
  write(lun,*)
  write(lun,'(8a12)') 'a/w','FA_L','FA_R','FA_avg','FC_L','FC_R','FC_avg','ierror'
end do
do i = 101,119,1
  count = count+1
  aonw  = i/1000.0d0
  clonr = aonw/ronw-1.0d0
  cronr = clonr
  call UCOCHFPUT(honw,donw,ronw,clonr,cronr,fal,far,fcl,fcr,ierror, &
                 deleteinfile,deleteoutfiles)
  faavg = (fal+far)/2.0d0
  fcavg = (fcl+fcr)/2.0d0
  do lun = 6,7
    write(lun,'(7f12.6,i12)') aonw,fal,far,faavg,fcl,fcr,fcavg,ierror
  end do
end do
do i = 12,80,1
  count = count+1
  aonw  = i/100.0d0
  clonr = aonw/ronw-1.0d0
  cronr = clonr
  call UCOCHFPUT(honw,donw,ronw,clonr,cronr,fal,far,fcl,fcr,ierror, &
                 deleteinfile,deleteoutfiles)
  faavg = (fal+far)/2.0d0
  fcavg = (fcl+fcr)/2.0d0
  do lun = 6,7
    write(lun,'(7f12.6,i12)') aonw,fal,far,faavg,fcl,fcr,fcavg,ierror
  end do
end do
etime1 = timef()
etime  = etime1-etime0
do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
end do

write(*,*)

close(lun)

end subroutine TestOtherCases

!===============================================================================

subroutine BetaUCHIPM(C1onR,C2onR,FA1,FA2,FC1,FC2)

! Compute Beta factor for two unequal cracks emanating from a circular
! hole in an infinite plate under uniform uniaxial load. Murakami's
! formula is used, with a range of validity of 0 <= c/r <= 1, where c
! is the length of the left or right crack.
!
! Input variables:
!
! C1onR = c1/r
! C2onR = c2/r
!
! Output variables:
!
! FA1 = Beta factor for left crack
! FA2 = Beta factor for right crack
```

```
! FC1 = Beta factor for left crack
! FC2 = Beta factor for right crack
!
! Stress intensity factors:
!
! Kl = S*sqrt(pi*a)*FA1
! Kr = S*sqrt(pi*a)*FA2
!
! Kl = S*sqrt(pi*cl)*FC1
! Kr = S*sqrt(pi*cr)*FC2
!
! r  = radius of circular hole
! c1 = length of left crack
! c2 = length of right crack
! S  = uniform remote tension stress
! a  = (c1 + 2*r + c2)/2
!
! Reference:
!
! Y Murakami. A method of stress intensity factor calculation for the
! crack emanating from an arbitrarily shaped hole. The Japan Society
! of Mechanical Engineers, Vol 44, No 378, 1978, pages 423-432.

implicit none

real*8 C1onR,C2onR,FC1,FC2,FA1,FA2

real*8 F,Flambda,Lambda,L

F(L) = 3.3645d0*(1.0d0+0.2238d0*L-0.1643d0*L**2)*      &
       (1.0d0/3.0d0+1.0d0/6.0d0*(1.0d0/(1.0d0+L)**2+   &
       3.0d0/(1.0d0+L)**4))

! Check to ensure that the crack sizes are within the range of
! validity, which is specified to be 0 <= c/r <= 1.

if (C1onR > 1.0d0 .or. C2onR > 1.0d0 .or.  &
    C1onR < 0.0d0 .or. C2onR < 0.0d0) then
  FA1 = 0.0d0
  FA2 = 0.0d0
  FC1 = 0.0d0
  FC2 = 0.0d0
  return
end if

! Compute Beta factor for 1st crack.

Lambda  = C1onR
Flambda = F(Lambda)
FA1     = Flambda*sqrt(C1onR/(1.0d0+C1onR))
FC1     = Flambda*sqrt((1.0d0+(C1onR+C2onR)/2.0d0)/(1.0d0+C1onR))

! Compute Beta factor for 2nd crack.

Lambda  = C2onR
Flambda = F(Lambda)
FA2     = Flambda*sqrt(C2onR/(1.0d0+C2onR))
FC2     = Flambda*sqrt((1.0d0+(C1onR+C2onR)/2.0d0)/(1.0d0+C2onR))

end subroutine BetaUCHIPM

!===============================================================================

subroutine BetaECHIPT(ConR,FA,FC)

! Compute Beta factors for two equal cracks emanating from a circular
! hole in an infinite plate under uniform uniaxial load. The formula
! used here was given in Figure 19.1 of the Tada, Paris and Irwin
```

```
! handbook.
!
! Input variables:
!
! ConR = c/r
!
! Output variables:
!
! FA = Beta factor
! FC = Beta factor
!
! Stress intensity factors:
!
! K = S*sqrt(pi*a)*FA
!
! K = S*sqrt(pi*c)*FC
!
! r = radius of circular hole
! c = length of cracks
! S = uniform remote tension stress
! a = r+c
!
! Reference:
!
! H Tada, PC Paris, GR Irwin. The Stress Analysis of Cracks Handbook,
! Third Edition. Professional Engineering Publishing, 2000.

implicit none

real*8 ConR,FA,FC

real*8 s

s  = ConR/(1.0d0+ConR)

FC = 0.50d0*(3.0d0-s)*(1.0d0+1.243d0*(1.0d0-s)**3)
FA = FC*sqrt(s)

end subroutine BetaECHIPT

!===============================================================================

subroutine TestRookeTweed(ofn)

! This routine is used to analyse a set of plate, hole and unequal crack
! geometries for comparison with the results published in the following
! report:
!
!   DP Rooke, J Tweed. Opening-Mode Stress Intensity Factors for Two
!   Unequal Cracks at a Hole. Royal Aircraft Establishment, Technical
!   Report 79105, August 1979.
!
! The results were obtained from Table 5, and are for an infinite plate.

implicit none

character ofn*(*)

integer, parameter:: nDataStr = 105
real*8,  parameter:: pi = datan(1.0d0)*4.0d0

real*8    L1onr,L2onr
real*8    FA1,FA2,FC1,FC2,FA2_RT,FC2_RT
real*8    FA1M,FA2M,FC1M,FC2M
real*8    etime0,etime1,etime
integer   i,ierror,count,lun
character DataStr(0:nDataStr)*64
logical   deleteinfile,deleteoutfiles
```

```
real*8    timef

DataStr(000) = ' L1/r     L2/r   FA2_RT   FC2_RT'
DataStr(001) = ' 0.00     0.01    0.328    3.291'
DataStr(002) = ' 0.00     0.02    0.454    3.223'
DataStr(003) = ' 0.00     0.05    0.667    3.036'
DataStr(004) = ' 0.00     0.10    0.853    2.771'
DataStr(005) = ' 0.00     0.15    0.953    2.555'
DataStr(006) = ' 0.00     0.20    1.013    2.373'
DataStr(007) = ' 0.00     0.30    1.067    2.092'
DataStr(008) = ' 0.00     0.50    1.091    1.727'
DataStr(009) = ' 0.00     0.70    1.082    1.517'
DataStr(010) = ' 0.00     1.00    1.066    1.306'
DataStr(011) = ' 0.00     1.50    1.044    1.127'
DataStr(012) = ' 0.00     2.00    1.030    1.030'
DataStr(013) = ' 0.00     3.00    1.018    0.930'
DataStr(014) = ' 0.00     5.00    1.010    0.845'
DataStr(015) = ' 0.00    10.00    1.005    0.779'
DataStr(016) = ' 0.50     0.01    0.312    3.490'
DataStr(017) = ' 0.50     0.02    0.431    3.418'
DataStr(018) = ' 0.50     0.05    0.638    3.220'
DataStr(019) = ' 0.50     0.10    0.816    2.941'
DataStr(020) = ' 0.50     0.15    0.912    2.711'
DataStr(021) = ' 0.50     0.20    0.970    2.520'
DataStr(022) = ' 0.50     0.30    1.028    2.221'
DataStr(023) = ' 0.50     0.50    1.058    1.832'
DataStr(024) = ' 0.50     0.70    1.055    1.595'
DataStr(025) = ' 0.50     1.00    1.041    1.378'
DataStr(026) = ' 0.50     1.50    1.024    1.182'
DataStr(027) = ' 0.50     2.00    1.013    1.075'
DataStr(028) = ' 0.50     3.00    1.004    0.962'
DataStr(029) = ' 0.50     5.00    1.000    0.866'
DataStr(030) = ' 0.50    10.00    1.000    0.790'
DataStr(031) = ' 1.00     0.01    0.306    3.749'
DataStr(032) = ' 1.00     0.02    0.422    3.672'
DataStr(033) = ' 1.00     0.05    0.626    3.460'
DataStr(034) = ' 1.00     0.10    0.803    3.161'
DataStr(035) = ' 1.00     0.15    0.900    2.915'
DataStr(036) = ' 1.00     0.20    0.958    2.710'
DataStr(037) = ' 1.00     0.30    1.018    2.388'
DataStr(038) = ' 1.00     0.50    1.052    1.968'
DataStr(039) = ' 1.00     0.70    1.052    1.710'
DataStr(040) = ' 1.00     1.00    1.040    1.471'
DataStr(041) = ' 1.00     1.50    1.024    1.254'
DataStr(042) = ' 1.00     2.00    1.014    1.134'
DataStr(043) = ' 1.00     3.00    1.005    1.005'
DataStr(044) = ' 1.00     5.00    1.000    0.895'
DataStr(045) = ' 1.00    10.00    0.999    0.806'
DataStr(046) = ' 2.00     0.01    0.298    4.216'
DataStr(047) = ' 2.00     0.02    0.412    4.130'
DataStr(048) = ' 2.00     0.05    0.618    3.893'
DataStr(049) = ' 2.00     0.10    0.786    3.558'
DataStr(050) = ' 2.00     0.15    0.882    3.282'
DataStr(051) = ' 2.00     0.20    0.942    3.052'
DataStr(052) = ' 2.00     0.30    1.005    2.690'
DataStr(053) = ' 2.00     0.50    1.043    2.213'
DataStr(054) = ' 2.00     0.70    1.047    1.918'
DataStr(055) = ' 2.00     1.00    1.039    1.643'
DataStr(056) = ' 2.00     1.50    1.025    1.388'
DataStr(057) = ' 2.00     2.00    1.016    1.244'
DataStr(058) = ' 2.00     3.00    1.007    1.087'
DataStr(059) = ' 2.00     5.00    1.001    0.950'
DataStr(060) = ' 2.00    10.00    1.000    0.836'
DataStr(061) = ' 5.00     0.01    0.284    5.324'
DataStr(062) = ' 5.00     0.02    0.394    5.216'
DataStr(063) = ' 5.00     0.05    0.586    4.920'
DataStr(064) = ' 5.00     0.10    0.756    4.501'
```

```
DataStr(065) = ' 5.00    0.15   0.851   4.156'
DataStr(066) = ' 5.00    0.20   0.911   3.866'
DataStr(067) = ' 5.00    0.30   0.977   3.410'
DataStr(068) = ' 5.00    0.50   1.024   2.803'
DataStr(069) = ' 5.00    0.70   1.033   2.423'
DataStr(070) = ' 5.00    1.00   1.031   2.061'
DataStr(071) = ' 5.00    1.50   1.021   1.719'
DataStr(072) = ' 5.00    2.00   1.014   1.522'
DataStr(073) = ' 5.00    3.00   1.007   1.300'
DataStr(074) = ' 5.00    5.00   1.002   1.098'
DataStr(075) = ' 5.00   10.00   1.000   0.922'
DataStr(076) = '10.00    0.01   0.274   6.708'
DataStr(077) = '10.00    0.02   0.379   6.574'
DataStr(078) = '10.00    0.05   0.565   6.206'
DataStr(079) = '10.00    0.10   0.731   5.685'
DataStr(080) = '10.00    0.15   0.826   5.254'
DataStr(081) = '10.00    0.20   0.886   4.892'
DataStr(082) = '10.00    0.30   0.954   4.320'
DataStr(083) = '10.00    0.50   1.006   3.555'
DataStr(084) = '10.00    0.70   1.019   3.070'
DataStr(085) = '10.00    1.00   1.022   2.604'
DataStr(086) = '10.00    1.50   1.016   2.156'
DataStr(087) = '10.00    2.00   1.012   1.893'
DataStr(088) = '10.00    3.00   1.006   1.590'
DataStr(089) = '10.00    5.00   1.002   1.306'
DataStr(090) = '10.00   10.00   1.000   1.049'
DataStr(091) = ' 0.01    0.01   0.328   3.293'
DataStr(092) = ' 0.02    0.02   0.452   3.225'
DataStr(093) = ' 0.05    0.05   0.663   3.041'
DataStr(094) = ' 0.10    0.10   0.840   2.786'
DataStr(095) = ' 0.15    0.15   0.932   2.581'
DataStr(096) = ' 0.20    0.20   0.985   2.412'
DataStr(097) = ' 0.30    0.30   1.035   2.156'
DataStr(098) = ' 0.50    0.50   1.058   1.832'
DataStr(099) = ' 0.70    0.70   1.053   1.642'
DataStr(100) = ' 1.00    1.00   1.041   1.472'
DataStr(101) = ' 1.50    1.50   1.025   1.323'
DataStr(102) = ' 2.00    2.00   1.016   1.244'
DataStr(103) = ' 3.00    3.00   1.007   1.163'
DataStr(104) = ' 5.00    5.00   1.002   1.098'
DataStr(105) = '10.00   10.00   1.000   1.049'

open(unit=7,file=ofn,status='unknown')

deleteinfile   = .true.
deleteoutfiles = .true.
count          = 0
etime0         = timef()

! _RT signifies result from Rooke and Tweed table.
! _M  signifies result from Murakami formula.

do lun = 6,7
  write(lun,'(17a13)') &
    'L1/r','L2/r','FA2_RT','FC2_RT','FA1','FA2','FA1_M','FA2_M', &
    'FC1','FC2','FC1_M','FC2_M', &
    'FA1_M/FA1','FA2_M/FA2_RT','FA2/FA2_RT','FC2/FC2_RT','ierror'
end do

do i = 1,nDataStr
  read(DataStr(i),*) L1onr,L2onr,FA2_RT, FC2_RT
  if (L1onr == 0.0d0) then
    L1onr = 0.0001d0
  end if
  if (L2onr == 0.0d0) then
    L2onr = 0.0001d0
  end if
  count = count+1
```

```
  call UCCHIPUT(L1onr,L2onr,FA1,FA2,FC1,FC2,ierror, &
                deleteinfile,deleteoutfiles)
  if (L1onr == 0.0001d0) then
    L1onr = 0.0d0
    FA1   = 0.0d0
  end if
  if (L2onr == 0.0001d0) then
    L2onr = 0.0d0
    FA2   = 0.0d0
  end if
  call BetaUCHIPM(L1onr,L2onr,FA1M,FA2M,FC1M,FC2M)
  do lun = 6,7
    write(lun,'(16f13.6,i13)')                           &
      L1onr,L2onr,FA2_RT,FC2_RT,FA1,FA2,FA1M,FA2M,       &
      FC1,FC2,FC1M,FC2M,                                 &
      FA1M/FA1,FA2M/FA2_RT,FA2/FA2_RT,FC2/FC2_RT,ierror
  end do
end do

etime1 = timef()
etime  = etime1-etime0

do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
end do

write(*,*)

close(7)

end subroutine TestRookeTweed

!===============================================================================

subroutine TestNisitaniIsida(ofn)

! This routine is used to analyse the Beta factors for the case of equal
! cracks growing from a circular hole in an infinite plate.
!
! References:
!
! H Nisitani, M Isida. Simple procedure for calculating KI of a notch
! with a crack of arbitrary size and its application to non-propagating
! fatigue crack. Proceedings of Joint JSME-SESA Conference on Experimental
! Mechanics, 1982, Part I, pages 150-155.

implicit none

character ofn*(*)

integer, parameter:: nDataStr = 20
real*8,  parameter:: pi = datan(1.0d0)*4.0d0

real*8    L1onr,L2onr
real*8    F_NI,FA1M,FA2M,FC1M,FC2M,F,FA1,FA2,FC1,FC2,FAS,FCS
real*8    etime0,etime1,etime
integer   i,ierror,count,lun
character DataStr(0:nDataStr)*32
logical   deleteinfile,deleteoutfiles

real*8    timef

DataStr(00) = '     c/r    F_NI'
DataStr(01) = '   0.001  0.1061'
DataStr(02) = '   0.010  0.3277'
DataStr(03) = '   0.020  0.4517'
```

```
DataStr(04) = '   0.050  0.6637'
DataStr(05) = '   0.100  0.8401'
DataStr(06) = '   0.200  0.9851'
DataStr(07) = '   0.300  1.0358'
DataStr(08) = '   0.400  1.0536'
DataStr(09) = '   0.500  1.0581'
DataStr(10) = '   0.600  1.0570'
DataStr(11) = '   0.800  1.0494'
DataStr(12) = '   1.000  1.0409'
DataStr(13) = '   2.000  1.0161'
DataStr(14) = '   3.000  1.0076'
DataStr(15) = '   5.000  1.0025'
DataStr(16) = '  10.000  0.0000'
DataStr(17) = '  50.000  0.0000'
DataStr(18) = ' 100.000  0.0000'
DataStr(19) = ' 500.000  0.0000'
DataStr(20) = '1000.000  0.0000'

open(unit=7,file=ofn,status='unknown')

deleteinfile   = .true.
deleteoutfiles = .true.
count          = 0
etime0         = timef()

do lun = 6,7
  write(lun,'(9a12)') 'c/r','F_NI','F_M','F_S','F','F_NI/F', &
                      'F_M/F','F_S/F','ierror'
end do

do i = 1,nDataStr
  read(DataStr(i),*) L1onr,F_NI
  L2onr = L1onr
  count = count+1
  call UCCHIPUT(L1onr,L2onr,FA1,FA2,FC1,FC2,ierror, &
                deleteinfile,deleteoutfiles)
  F = (FA1+FA2)/2.0d0
  call BetaUCHIPM(L1onr,L2onr,FA1M,FA2M,FC1M,FC2M)
  call BetaECHIPS(L1onr,FAS,FCS)
  do lun = 6,7
    write(lun,'(8f12.6,i12)') &
      L1onr,F_NI,FA1M,FAS,F,F_NI/F,FA1M/F,FAS/F,ierror
  end do
end do

etime1 = timef()
etime  = etime1-etime0

do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
end do

write(*,*)

close(7)

end subroutine TestNisitaniIsida

!===============================================================================

subroutine TestIsidaNakamura(ofn)

! This routine is used to analyse a set of plate, hole and unequal crack
! geometries for comparison with the results published in the following
! journal paper:
!
```

```
!   M Isida, Y Nakamura. Edge cracks originating from an elliptical hole
!   in a wide plate subjected to tension and in-plane shear. Transactions
!   of the Japan Society of Mechanical Engineers, Vol 46, No 409, 1980,
!   pages 947-956.
!
! The cases reported there cover crack lengths, c, in the range
! 0 <= c/r <= 1.0, and include results for circular holes.

implicit none

character ofn*(*)

integer, parameter:: nDataStr = 63
real*8,  parameter:: pi = datan(1.0d0)*4.0d0

real*8    F,C1onr,C2onr
real*8    FA1,FA2,FC1,FC2,FC1_IN
real*8    FA1M,FA2M,FC1M,FC2M
real*8    etime0,etime1,etime
integer   i,ierror,count,lun
character DataStr(0:nDataStr)*64
logical   deleteinfile,deleteoutfiles

real*8    timef

DataStr(00) = ' C1/r    C2/r  FC1_IN'
DataStr(01) = ' 0.10    0.00   2.773'
DataStr(02) = ' 0.10    0.10   2.787'
DataStr(03) = ' 0.10    0.20   2.817'
DataStr(04) = ' 0.10    0.40   2.898'
DataStr(05) = ' 0.10    0.60   2.987'
DataStr(06) = ' 0.10    0.80   3.065'
DataStr(07) = ' 0.10    1.00   3.163'
DataStr(08) = ' 0.20    0.00   2.375'
DataStr(09) = ' 0.20    0.10   2.387'
DataStr(10) = ' 0.20    0.20   2.413'
DataStr(11) = ' 0.20    0.40   2.483'
DataStr(12) = ' 0.20    0.60   2.559'
DataStr(13) = ' 0.20    0.80   2.636'
DataStr(14) = ' 0.20    1.00   2.709'
DataStr(15) = ' 0.40    0.00   1.885'
DataStr(16) = ' 0.40    0.10   1.895'
DataStr(17) = ' 0.40    0.20   1.916'
DataStr(18) = ' 0.40    0.40   1.971'
DataStr(19) = ' 0.40    0.60   2.031'
DataStr(20) = ' 0.40    0.80   2.092'
DataStr(21) = ' 0.40    1.00   2.151'
DataStr(22) = ' 0.60    0.00   1.605'
DataStr(23) = ' 0.60    0.10   1.613'
DataStr(24) = ' 0.60    0.20   1.630'
DataStr(25) = ' 0.60    0.40   1.676'
DataStr(26) = ' 0.60    0.60   1.726'
DataStr(27) = ' 0.60    0.80   1.776'
DataStr(28) = ' 0.60    1.00   1.826'
DataStr(29) = ' 0.80    0.00   1.427'
DataStr(30) = ' 0.80    0.10   1.434'
DataStr(31) = ' 0.80    0.20   1.449'
DataStr(32) = ' 0.80    0.40   1.488'
DataStr(33) = ' 0.80    0.60   1.531'
DataStr(34) = ' 0.80    0.80   1.574'
DataStr(35) = ' 0.80    1.00   1.616'
DataStr(36) = ' 1.00    0.00   1.306'
DataStr(37) = ' 1.00    0.10   1.312'
DataStr(38) = ' 1.00    0.20   1.325'
DataStr(39) = ' 1.00    0.40   1.359'
DataStr(40) = ' 1.00    0.60   1.397'
DataStr(41) = ' 1.00    0.80   1.435'
DataStr(42) = ' 1.00    1.00   1.472'
```

```
DataStr(43) = ' 0.00    0.00   3.3645'
DataStr(44) = ' 0.10    0.00   0.000'
DataStr(45) = ' 0.20    0.00   0.000'
DataStr(46) = ' 0.30    0.00   0.000'
DataStr(46) = ' 0.40    0.00   0.000'
DataStr(47) = ' 0.50    0.00   0.000'
DataStr(48) = ' 0.60    0.00   0.000'
DataStr(49) = ' 0.70    0.00   0.000'
DataStr(50) = ' 0.80    0.00   0.000'
DataStr(51) = ' 0.90    0.00   0.000'
DataStr(52) = ' 1.00    0.00   0.000'
DataStr(53) = ' 0.00    0.00   3.3645'
DataStr(54) = ' 0.00    0.10   0.000'
DataStr(55) = ' 0.00    0.20   0.000'
DataStr(56) = ' 0.00    0.30   0.000'
DataStr(57) = ' 0.00    0.40   0.000'
DataStr(58) = ' 0.00    0.50   0.000'
DataStr(59) = ' 0.00    0.60   0.000'
DataStr(60) = ' 0.00    0.70   0.000'
DataStr(61) = ' 0.00    0.80   0.000'
DataStr(62) = ' 0.00    0.90   0.000'
DataStr(63) = ' 0.00    1.00   0.000'

open(unit=7,file=ofn,status='unknown')

deleteinfile   = .true.
deleteoutfiles = .true.
count          = 0
etime0         = timef()

! _IN signifies result from Isida and Nakamura table.
! _M  signifies result from Murakami formula.

do lun = 6,7
  write(lun,'(11a13)') &
    'C1/r','C2/r','FC1_IN','FC1','FC2','FC1_M','FC2_M', &
    'FC1_M/FC1','FC1_M/FC1_IN','FC1/FC1_IN','ierror'
end do

do i = 1,nDataStr
  read(DataStr(i),*) C1onr,C2onr,FC1_IN
  if (C1onr == 0.0d0) then
    C1onr = 0.0001d0
  end if
  if (C2onr == 0.0d0) then
    C2onr = 0.0001d0
  end if
  count = count+1
  call UCCHIPUT(C1onr,C2onr,FA1,FA2,FC1,FC2,ierror, &
                deleteinfile,deleteoutfiles)
  if (C1onr == 0.0001d0) then
    C1onr = 0.0d0
    FA1   = 0.0d0
  end if
  if (C2onr == 0.0001d0) then
    C2onr = 0.0d0
    FA2   = 0.0d0
  end if
  if (C1onr == 0.0d0 .and. C2onr == 0.0d0) then
    F   = (FC1+FC2)/2.0d0
    FC1 = F
    FC2 = F
  end if
  call BetaUCHIPM(C1onr,C2onr,FA1M,FA2M,FC1M,FC2M)
  do lun = 6,7
    if (i <= 42) then
      write(lun,'(10f13.6,i13)')                  &
        C1onr,C2onr,FC1_IN,FC1,FC2,FC1M,FC2M,    &
```

```
        FC1M/FC1,FC1M/FC1_IN,FC1/FC1_IN,ierror
   else
      write(lun,'(2f13.6,a13,5f13.6,2a13,i13)')  &
        C1onr,C2onr,'',FC1,FC2,FC1M,FC2M,        &
        FC1M/FC1,'','',ierror
   end if
  end do
end do

etime1 = timef()
etime  = etime1-etime0

do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
end do

write(*,*)

close(7)

end subroutine TestIsidaNakamura

!===============================================================================

subroutine TestMurakami(ofn)

! This routine is used to analyse a set of plate, hole and unequal crack
! geometries for comparison with the results published in the following
! journal paper:
!
! Y Murakami. A method of stress intensity factor calculation for the
! crack emanating from an arbitrarily shaped hole. The Japan Society
! of Mechanical Engineers, Vol 44, No 378, 1978, pages 423-432.

implicit none

character ofn*(*)

integer,  parameter:: nDataStr = 8
real*8,   parameter:: pi = datan(1.0d0)*4.0d0

real*8    CLonr,CRonr
real*8    FA1,FA2,FC1,FC2,FCL_M,FCR_M
real*8    FA1M,FA2M,FC1M,FC2M
real*8    etime0,etime1,etime
integer   i,ierror,count,lun
character DataStr(0:nDataStr)*64
logical   deleteinfile,deleteoutfiles

real*8    timef

DataStr(0) = ' CL/r    CR/r   FCL_M   FCR_M'
DataStr(1) = ' 0.05    0.05   2.961   2.961'
DataStr(2) = ' 0.10    0.05   2.772   2.971'
DataStr(3) = ' 0.20    0.05   2.376   3.003'
DataStr(4) = ' 0.40    0.05   1.873   3.037'
DataStr(5) = ' 0.80    0.05   1.440   3.332'
DataStr(6) = ' 0.30    0.10   2.102   2.851'
DataStr(7) = ' 0.70    0.10   1.514   3.026'
DataStr(8) = ' 1.10    0.10   1.265   3.199'

open(unit=7,file=ofn,status='unknown')

deleteinfile   = .true.
deleteoutfiles = .true.
count          = 0
```

```
etime0          = timef()

do lun = 6,7
  write(lun,'(11a13)') &
    'CL/r','CR/r','FCL_M','FCR_M','FCL','FCR','FC1M','FC2M', &
    'FCL_M/FC1','FC1M/FC1','ierror'
end do

do i = 1,nDataStr
  read(DataStr(i),*) CLonr,CRonr,FCL_M,FCR_M
  count = count+1
  call UCCHIPUT(CLonr,CRonr,FA1,FA2,FC1,FC2,ierror, &
                deleteinfile,deleteoutfiles)
  call BetaUCHIPM(CLonr,CRonr,FA1M,FA2M,FC1M,FC2M)
  do lun = 6,7
    write(lun,'(10f13.6,i13)')                     &
      CLonr,CRonr,FCL_M,FCR_M,FC1,FC2,FC1M,FC2M,   &
      FCL_M/FC1,FC1M/FC1,ierror
  end do
end do

etime1 = timef()
etime  = etime1-etime0

do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
end do

write(*,*)

close(7)

end subroutine TestMurakami

!===============================================================================

subroutine TestAnalyticalEqualCracksIP(ofn)

! This routine is used to analyse the Beta factors for the case of equal
! cracks growing from a circular hole in an infinite plate.
!
! References:
!
! Y Murakami. A method of stress intensity factor calculation for the
! crack emanating from an arbitrarily shaped hole. The Japan Society
! of Mechanical Engineers, Vol 44, No 378, 1978, pages 423-432.
!
! H Tada, PC Paris, GR Irwin. The Stress Analysis of Cracks Handbook,
! Third Edition. Professional Engineering Publishing, 2000.

implicit none

character ofn*(*)

real*8, parameter:: pi = datan(1.0d0)*4.0d0

real*8  L1onr,L2onr
real*8  FAF,FCF,FA1M,FA2M,FC1M,FC2M,FA1,FA2,FC1,FC2,FA,FC,FAS,FCS,FAIS,FCIS
real*8  etime0,etime1,etime
integer i,j,imax,jmin,ierror,count,lun
logical deleteinfile,deleteoutfiles

real*8  timef

open(unit=7,file=ofn,status='unknown')
```

```
deleteinfile   = .true.
deleteoutfiles = .true.
count          = 0
etime0         = timef()

do lun = 6,7
  write(lun,'(15a11)') &
    'c/r','FA_F','FA_IS','FA_M','FA_T','FA_S','FA_S/FA_F', &
          'FC_F','FC_IS','FC_M','FC_T','FC_S','FC_T/FC_F','FC_S/FC_F','ierror'
end do

jmin = -2

do j = 3,jmin,-1
  if (j > jmin) then
    imax = 9
  else
    imax = 10
  end if
  do i = 1,imax
    L1onr = i*10.0d0**(-j)
    L2onr = L1onr
    count = count+1
    call UCCHIPUT(L1onr,L2onr,FA1,FA2,FC1,FC2,ierror, &
                  deleteinfile,deleteoutfiles)
    FAF = (FA1+FA2)/2.0d0
    FCF = (FC1+FC2)/2.0d0
    call BetaUCHIPM(L1onr,L2onr,FA1M,FA2M,FC1M,FC2M)
    call BetaECHIPT(L1onr,FA,FC)
    call BetaECHIPS(L1onr,FAS,FCS)
    call BetaECHFWIS(L1onr,0.0d0,FAIS,FCIS)
    do lun = 6,7
      if (L1onr <= 1.0d0) then
        write(lun,'(14f11.6,i11)') &
          L1onr,FAF,FAIS,FA1M,FA,FAS,FAS/FAF, &
          FCF,FCIS,FC1M,FC,FCS,FC/FCF,FCS/FCF,ierror
      else
        write(lun,'(3f11.6,a11,5f11.6,a11,4f11.6,i11)') &
          L1onr,FAF,FAIS,'',FA,FAS,FAS/FAF, &
          FCF,FCIS,'',FC,FCS,FC/FCF,FCS/FCF,ierror
      end if
    end do
  end do
end do

etime1 = timef()
etime  = etime1-etime0

do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
end do

write(*,*)

close(7)

end subroutine TestAnalyticalEqualCracksIP

!===============================================================================

subroutine TestStressCheck(ofn)

! This routine is used to analyse a set of plate, hole and unequal crack
! geometries for comparison with the StressCheck results published in the
! following report:
!
```

```
!   James A. Harter, Deviprasad Taluk. Life Analysis Development and
!   Verification: Damage Tolerance Application of Multiple Through
!   Cracks in Plates With and Without Holes. AFRL-VA-WP-TR-2004-3112,
!   October 2004.
!
! The results for a centred hole were found in Tables E1.x, while the
! results for an offset hole were found in Tables E2.x.

implicit none

character ofn*(*)

integer, parameter:: nDataStr = 448
real*8,  parameter:: pi = datan(1.0d0)*4.0d0

real*8    r,clonr,cronr,donw,ronw,fal,far,fcl,fcr,a
real*8    HonW,W,B,D,C1,C2,C1pC2onW,SIF1,SIF2,FA1,FA2
real*8    etime0,etime1,etime
integer   i,ierror,count,lun
character DataStr(0:nDataStr)*64
logical   deleteinfile,deleteoutfiles

real*8    timef

DataStr(000) = 'Case  H/W     W      B     D     C1     C2  (C1+C2)/W   K1_SC   K2_SC'
DataStr(001) = 'E1.1    4 40.00 20.00 0.25  0.15   3.00   0.07875  2.3040  2.3100'
DataStr(002) = 'E1.1    4 40.00 20.00 0.25  0.25   5.00   0.13125  2.9730  2.9760'
DataStr(003) = 'E1.1    4 40.00 20.00 0.25  0.39   7.80   0.20475  3.7510  3.7840'
DataStr(004) = 'E1.1    4 40.00 20.00 0.25  0.50  10.00   0.26250  4.3300  4.4210'
DataStr(005) = 'E1.1    4 40.00 20.00 0.25  0.65  13.00   0.34125  5.2180  5.5000'
DataStr(006) = 'E1.1    4 40.00 20.00 0.25  0.80  16.00   0.42000  6.3180  7.4070'
DataStr(007) = 'E1.1    4 40.00 20.00 0.25  0.85  17.00   0.44625  6.7720  8.6050'
DataStr(008) = 'E1.1    4 40.00 20.00 0.25  0.90  18.00   0.47250  7.5320 10.6560'
DataStr(009) = 'E1.1    4 40.00 20.00 0.25  0.30   3.00   0.08250  2.3770  2.3620'
DataStr(010) = 'E1.1    4 40.00 20.00 0.25  0.40   4.00   0.11000  2.7250  2.7180'
DataStr(011) = 'E1.1    4 40.00 20.00 0.25  0.50   5.00   0.13750  3.0310  3.0390'
DataStr(012) = 'E1.1    4 40.00 20.00 0.25  0.80   8.00   0.22000  3.8990  3.9250'
DataStr(013) = 'E1.1    4 40.00 20.00 0.25  0.95   9.50   0.26125  4.3100  4.3740'
DataStr(014) = 'E1.1    4 40.00 20.00 0.25  1.20  12.00   0.33000  5.0270  5.2430'
DataStr(015) = 'E1.1    4 40.00 20.00 0.25  1.35  13.50   0.37125  5.4870  5.9170'
DataStr(016) = 'E1.1    4 40.00 20.00 0.25  1.50  15.00   0.41250  6.0310  6.8320'
DataStr(017) = 'E1.1    4 40.00 20.00 0.25  1.65  16.50   0.45375  6.6800  8.2640'
DataStr(018) = 'E1.1    4 40.00 20.00 0.25  1.80  18.00   0.49500  7.6900 11.1200'
DataStr(019) = 'E1.1    4 40.00 20.00 0.25  0.40   2.80   0.08000  2.2350  2.3300'
DataStr(020) = 'E1.1    4 40.00 20.00 0.25  0.60   4.20   0.12000  2.8400  2.8450'
DataStr(021) = 'E1.1    4 40.00 20.00 0.25  0.80   5.60   0.16000  3.2700  3.2950'
DataStr(022) = 'E1.1    4 40.00 20.00 0.25  1.10   7.70   0.22000  3.8990  3.9350'
DataStr(023) = 'E1.1    4 40.00 20.00 0.25  1.40   9.80   0.28000  4.4810  4.5930'
DataStr(024) = 'E1.1    4 40.00 20.00 0.25  1.70  11.90   0.34000  5.1030  5.3630'
DataStr(025) = 'E1.1    4 40.00 20.00 0.25  2.00  14.00   0.40000  5.7830  6.3880'
DataStr(026) = 'E1.1    4 40.00 20.00 0.25  2.20  15.40   0.44000  6.3160  7.3900'
DataStr(027) = 'E1.1    4 40.00 20.00 0.25  2.50  17.50   0.50000  7.3570 10.2640'
DataStr(028) = 'E1.1    4 40.00 20.00 0.25  0.50   2.50   0.07500  2.2640  2.2610'
DataStr(029) = 'E1.1    4 40.00 20.00 0.25  1.00   5.00   0.15000  3.1750  3.1760'
DataStr(030) = 'E1.1    4 40.00 20.00 0.25  1.60   8.00   0.24000  4.0840  4.1240'
DataStr(031) = 'E1.1    4 40.00 20.00 0.25  2.00  10.00   0.30000  4.6630  4.7880'
DataStr(032) = 'E1.1    4 40.00 20.00 0.25  2.50  12.50   0.37500  5.3740  5.7900'
DataStr(033) = 'E1.1    4 40.00 20.00 0.25  2.80  14.00   0.42000  5.9220  6.6040'
DataStr(034) = 'E1.1    4 40.00 20.00 0.25  3.20  16.00   0.48000  6.8160  8.3110'
DataStr(035) = 'E1.1    4 40.00 20.00 0.25  3.50  17.50   0.52500  7.6740 10.7580'
DataStr(036) = 'E1.1    4 40.00 20.00 0.25  0.60   1.80   0.06000  1.9700  1.9900'
DataStr(037) = 'E1.1    4 40.00 20.00 0.25  1.00   3.00   0.10000  2.5860  2.5870'
DataStr(038) = 'E1.1    4 40.00 20.00 0.25  2.00   6.00   0.20000  3.6210  3.6780'
DataStr(039) = 'E1.1    4 40.00 20.00 0.25  3.00   9.00   0.30000  4.5380  4.6940'
DataStr(040) = 'E1.1    4 40.00 20.00 0.25  4.00  12.00   0.40000  5.5500  5.9420'
DataStr(041) = 'E1.1    4 40.00 20.00 0.25  5.00  15.00   0.50000  6.8110  7.9880'
DataStr(042) = 'E1.1    4 40.00 20.00 0.25  6.00  18.00   0.60000  8.4630 13.6700'
DataStr(043) = 'E1.1    4 40.00 20.00 0.25  0.80   1.20   0.05000  1.8250  1.8210'
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DataStr(044) = 'E1.1    4 40.00 20.00 0.25  2.00  3.00   0.12500  2.8940  2.8950'
DataStr(045) = 'E1.1    4 40.00 20.00 0.25  4.00  6.00   0.25000  4.1000  4.1380'
DataStr(046) = 'E1.1    4 40.00 20.00 0.25  6.00  9.00   0.37500  5.2660  5.3730'
DataStr(047) = 'E1.1    4 40.00 20.00 0.25  8.00 12.00   0.50000  6.6390  6.9390'
DataStr(048) = 'E1.1    4 40.00 20.00 0.25 10.00 15.00   0.62500  8.2070  9.6060'
DataStr(049) = 'E1.1    4 40.00 20.00 0.25 12.00 18.00   0.75000 10.4150 16.7130'
DataStr(050) = 'E1.1    4 40.00 20.00 0.25  1.00  1.00   0.05000  1.8410  1.8410'
DataStr(051) = 'E1.1    4 40.00 20.00 0.25  3.00  3.00   0.15000  3.1760  3.1760'
DataStr(052) = 'E1.1    4 40.00 20.00 0.25  4.00  4.00   0.20000  3.6880  3.6880'
DataStr(053) = 'E1.1    4 40.00 20.00 0.25  5.00  5.00   0.25000  4.1340  4.1340'
DataStr(054) = 'E1.1    4 40.00 20.00 0.25  8.00  8.00   0.40000  5.5840  5.5840'
DataStr(055) = 'E1.1    4 40.00 20.00 0.25 12.00 12.00   0.60000  8.0970  8.0970'
DataStr(056) = 'E1.1    4 40.00 20.00 0.25 15.00 15.00   0.75000 11.3550 11.3550'
DataStr(057) = 'E1.1    4 40.00 20.00 0.25 16.00 16.00   0.80000 13.1580 13.1580'
DataStr(058) = 'E1.1    4 40.00 20.00 0.25 18.00 18.00   0.90000 20.3500 20.3500'
DataStr(059) = 'E1.1    4 40.00 20.00 0.25  0.80  1.60   0.06000  2.0440  2.0380'
DataStr(060) = 'E1.1    4 40.00 20.00 0.25  2.00  4.00   0.15000  3.1708  3.1770'
DataStr(061) = 'E1.1    4 40.00 20.00 0.25  4.00  8.00   0.30000  4.6440  4.6920'
DataStr(062) = 'E1.1    4 40.00 20.00 0.25  6.00 12.00   0.45000  6.0920  6.4930'
DataStr(063) = 'E1.1    4 40.00 20.00 0.25  7.00 14.00   0.52500  6.9420  7.8470'
DataStr(064) = 'E1.1    4 40.00 20.00 0.25  8.00 16.00   0.60000  7.9930 10.0890'
DataStr(065) = 'E1.1    4 40.00 20.00 0.25  9.00 18.00   0.67500  9.5070 15.2250'
DataStr(066) = 'E1.1    4 40.00 20.00 0.25  0.40  1.60   0.05000  1.8790  1.8710'
DataStr(067) = 'E1.1    4 40.00 20.00 0.25  1.00  4.00   0.12500  2.8910  2.8970'
DataStr(068) = 'E1.1    4 40.00 20.00 0.25  2.00  8.00   0.25000  4.1810  4.2210'
DataStr(069) = 'E1.1    4 40.00 20.00 0.25  3.00 12.00   0.37500  5.4070  5.7000'
DataStr(070) = 'E1.1    4 40.00 20.00 0.25  3.50 14.00   0.43750  6.1150  6.8140'
DataStr(071) = 'E1.1    4 40.00 20.00 0.25  4.00 16.00   0.50000  6.9960  8.6090'
DataStr(072) = 'E1.1    4 40.00 20.00 0.25  4.50 18.00   0.56250  8.3440 12.6840'
DataStr(073) = 'E1.2    4 40.00 20.00 2.50  0.50 10.00   0.26250  4.8780  4.9900'
DataStr(074) = 'E1.2    4 40.00 20.00 2.50  0.80 16.00   0.42000  7.1860  9.2780'
DataStr(075) = 'E1.2    4 40.00 20.00 2.50  0.90 18.00   0.47250  9.1600 17.1250'
DataStr(076) = 'E1.2    4 40.00 20.00 2.50  1.00 10.00   0.27500  5.1270  5.1490'
DataStr(077) = 'E1.2    4 40.00 20.00 2.50  1.25 12.50   0.34375  5.8970  6.2630'
DataStr(078) = 'E1.2    4 40.00 20.00 2.50  1.80 18.00   0.49500  9.5260 18.1600'
DataStr(079) = 'E1.2    4 40.00 20.00 2.50  1.00  7.00   0.20000  4.3820  4.2860'
DataStr(080) = 'E1.2    4 40.00 20.00 2.50  2.00 14.00   0.40000  6.5010  7.4690'
DataStr(081) = 'E1.2    4 40.00 20.00 2.50  2.50 17.50   0.50000  8.8240 14.8250'
DataStr(082) = 'E1.2    4 40.00 20.00 2.50  1.00  5.00   0.15000  3.8920  3.7650'
DataStr(083) = 'E1.2    4 40.00 20.00 2.50  2.50 12.50   0.37500  6.0750  6.6380'
DataStr(084) = 'E1.2    4 40.00 20.00 2.50  3.50 17.50   0.52500  9.0570 15.5620'
DataStr(085) = 'E1.2    4 40.00 20.00 2.50  3.00  9.00   0.30000  5.2150  5.3360'
DataStr(086) = 'E1.2    4 40.00 20.00 2.50  5.00 15.00   0.50000  7.5810  9.5630'
DataStr(087) = 'E1.2    4 40.00 20.00 2.50  6.00 18.00   0.60000 10.4770 22.5060'
DataStr(088) = 'E1.2    4 40.00 20.00 2.50  4.00  6.00   0.25000  4.7510  4.7270'
DataStr(089) = 'E1.2    4 40.00 20.00 2.50 10.00 15.00   0.62500  9.1610 11.4280'
DataStr(090) = 'E1.2    4 40.00 20.00 2.50 12.00 18.00   0.75000 12.6380 27.9880'
DataStr(091) = 'E1.2    4 40.00 20.00 2.50  5.00  5.00   0.25000  4.7170  4.7170'
DataStr(092) = 'E1.2    4 40.00 20.00 2.50 15.00 15.00   0.75000 13.4300 13.4300'
DataStr(093) = 'E1.2    4 40.00 20.00 2.50 18.00 18.00   0.90000 33.0300 33.0300'
DataStr(094) = 'E1.3    4 40.00 20.00 5.00  0.50 10.00   0.26250  5.1430  5.8720'
DataStr(095) = 'E1.3    4 40.00 20.00 5.00  0.70 14.00   0.36750  6.7380  8.7180'
DataStr(096) = 'E1.3    4 40.00 20.00 5.00  0.85 17.00   0.44625  9.6650 22.4850'
DataStr(097) = 'E1.3    4 40.00 20.00 5.00  1.00 10.00   0.27500  5.7700  5.9920'
DataStr(098) = 'E1.3    4 40.00 20.00 5.00  1.25 12.50   0.34375  6.6600  7.5020'
DataStr(099) = 'E1.3    4 40.00 20.00 5.00  1.70 17.00   0.46750 10.4690 23.5270'
DataStr(100) = 'E1.3    4 40.00 20.00 5.00  1.00  7.00   0.20000  5.0130  4.9890'
DataStr(101) = 'E1.3    4 40.00 20.00 5.00  2.00 14.00   0.40000  7.5660  9.2380'
DataStr(102) = 'E1.3    4 40.00 20.00 5.00  2.40 16.80   0.48000 10.2190 20.8090'
DataStr(103) = 'E1.3    4 40.00 20.00 5.00  1.00  5.00   0.15000  4.5480  4.4760'
DataStr(104) = 'E1.3    4 40.00 20.00 5.00  2.50 12.50   0.37500  7.0350  7.8890'
DataStr(105) = 'E1.3    4 40.00 20.00 5.00  3.40 17.00   0.51000 11.0030 25.7320'
DataStr(106) = 'E1.3    4 40.00 20.00 5.00  3.00  9.00   0.30000  6.0400  6.1340'
DataStr(107) = 'E1.3    4 40.00 20.00 5.00  5.00 15.00   0.50000  8.8010 12.3850'
DataStr(108) = 'E1.3    4 40.00 20.00 5.00  5.50 16.50   0.55000 10.4270 20.1960'
DataStr(109) = 'E1.3    4 40.00 20.00 5.00  4.00  6.00   0.25000  5.4640  5.4520'
DataStr(110) = 'E1.3    4 40.00 20.00 5.00 10.00 15.00   0.62500 10.6130 14.7510'
DataStr(111) = 'E1.3    4 40.00 20.00 5.00 11.00 16.50   0.68750 12.5490 24.4950'
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DataStr(112) = 'E1.3    4 40.00 20.00 5.00  5.00  5.00   0.25000  5.4470  5.4470'
DataStr(113) = 'E1.3    4 40.00 20.00 5.00 15.00 15.00   0.75000 17.2070 17.2070'
DataStr(114) = 'E1.3    4 40.00 20.00 5.00 17.00 17.00   0.85000 40.9640 40.9640'
DataStr(115) = 'E1.4    4 20.00 10.00 0.25  0.20  4.00   0.21000  2.7230  2.7140'
DataStr(116) = 'E1.4    4 20.00 10.00 0.25  0.30  6.00   0.31500  3.5150  3.6180'
DataStr(117) = 'E1.4    4 20.00 10.00 0.25  0.45  9.00   0.47250  5.4050  7.7790'
DataStr(118) = 'E1.4    4 20.00 10.00 0.25  0.20  2.00   0.11000  1.9540  1.9300'
DataStr(119) = 'E1.4    4 20.00 10.00 0.25  0.50  5.00   0.27500  3.1900  3.2410'
DataStr(120) = 'E1.4    4 20.00 10.00 0.25  0.90  9.00   0.49500  5.5200  8.2240'
DataStr(121) = 'E1.4    4 20.00 10.00 0.25  0.40  2.80   0.16000  2.3580  2.3620'
DataStr(122) = 'E1.4    4 20.00 10.00 0.25  0.80  5.60   0.32000  3.4870  3.6360'
DataStr(123) = 'E1.4    4 20.00 10.00 0.25  1.20  8.40   0.48000  5.0260  6.5300'
DataStr(124) = 'E1.4    4 20.00 10.00 0.25  0.60  3.00   0.18000  2.5110  2.5120'
DataStr(125) = 'E1.4    4 20.00 10.00 0.25  1.20  6.00   0.36000  3.7650  3.9890'
DataStr(126) = 'E1.4    4 20.00 10.00 0.25  1.80  9.00   0.54000  5.8320  8.9510'
DataStr(127) = 'E1.4    4 20.00 10.00 0.25  0.80  2.40   0.16000  2.3690  2.3660'
DataStr(128) = 'E1.4    4 20.00 10.00 0.25  2.00  6.00   0.40000  4.0150  4.2820'
DataStr(129) = 'E1.4    4 20.00 10.00 0.25  3.00  9.00   0.60000  6.2670 10.1210'
DataStr(130) = 'E1.4    4 20.00 10.00 0.25  1.00  1.50   0.12500  2.1030  2.0990'
DataStr(131) = 'E1.4    4 20.00 10.00 0.25  4.00  6.00   0.50000  4.7450  5.0130'
DataStr(132) = 'E1.4    4 20.00 10.00 0.25  6.00  9.00   0.75000  7.6640 12.4800'
DataStr(133) = 'E1.4    4 20.00 10.00 0.25  1.00  1.00   0.10000  1.8840  1.8840'
DataStr(134) = 'E1.4    4 20.00 10.00 0.25  5.00  5.00   0.50000  4.8160  4.8160'
DataStr(135) = 'E1.4    4 20.00 10.00 0.25  9.00  9.00   0.90000 14.8680 14.8680'
DataStr(136) = 'E1.5    4  8.00  4.00 0.25  0.10  2.00   0.26250  2.0190  2.1080'
DataStr(137) = 'E1.5    4  8.00  4.00 0.25  0.15  3.00   0.39375  2.7520  3.1960'
DataStr(138) = 'E1.5    4  8.00  4.00 0.25  0.19  3.80   0.49875  4.4630 10.2000'
DataStr(139) = 'E1.5    4  8.00  4.00 0.25  0.20  2.00   0.27500  2.1030  2.1640'
DataStr(140) = 'E1.5    4  8.00  4.00 0.25  0.30  3.00   0.41250  2.8630  3.3150'
DataStr(141) = 'E1.5    4  8.00  4.00 0.25  0.36  3.60   0.49500  3.7300  5.9510'
DataStr(142) = 'E1.5    4  8.00  4.00 0.25  0.30  2.10   0.30000  2.2250  2.2920'
DataStr(143) = 'E1.5    4  8.00  4.00 0.25  0.40  2.80   0.40000  2.7320  3.0580'
DataStr(144) = 'E1.5    4  8.00  4.00 0.25  0.50  3.50   0.50000  3.5890  5.3320'
DataStr(145) = 'E1.5    4  8.00  4.00 0.25  0.40  2.00   0.30000  2.2090  2.2760'
DataStr(146) = 'E1.5    4  8.00  4.00 0.25  0.60  3.00   0.45000  2.9920  3.5510'
DataStr(147) = 'E1.5    4  8.00  4.00 0.25  0.72  3.60   0.54000  3.9240  6.5550'
DataStr(148) = 'E1.5    4  8.00  4.00 0.25  0.80  2.40   0.40000  2.6420  2.8330'
DataStr(149) = 'E1.5    4  8.00  4.00 0.25  1.00  3.00   0.50000  3.2060  3.8630'
DataStr(150) = 'E1.5    4  8.00  4.00 0.25  1.20  3.60   0.60000  4.1860  7.2510'
DataStr(151) = 'E1.5    4  8.00  4.00 0.25  1.00  1.50   0.31250  2.2390  2.2550'
DataStr(152) = 'E1.5    4  8.00  4.00 0.25  2.00  3.00   0.62500  3.8800  4.6320'
DataStr(153) = 'E1.5    4  8.00  4.00 0.25  2.50  3.75   0.78125  5.7380 13.6900'
DataStr(154) = 'E1.5    4  8.00  4.00 0.25  0.80  0.80   0.20000  1.7640  1.7640'
DataStr(155) = 'E1.5    4  8.00  4.00 0.25  2.80  2.80   0.70000  4.7650  4.7650'
DataStr(156) = 'E1.5    4  8.00  4.00 0.25  3.70  3.70   0.92500 13.6600 13.6600'
DataStr(157) = 'E1.6    4  4.00  2.00 0.25  0.05  1.00   0.26250  1.5423  1.5962'
DataStr(158) = 'E1.6    4  4.00  2.00 0.25  0.08  1.60   0.42000  2.2622  2.9340'
DataStr(159) = 'E1.6    4  4.00  2.00 0.25  0.09  1.80   0.47250  2.9385  5.4352'
DataStr(160) = 'E1.6    4  4.00  2.00 0.25  0.10  1.00   0.27500  1.6334  1.6375'
DataStr(161) = 'E1.6    4  4.00  2.00 0.25  0.13  1.25   0.34375  1.8560  1.9840'
DataStr(162) = 'E1.6    4  4.00  2.00 0.25  0.18  1.80   0.49500  2.9810  5.7702'
DataStr(163) = 'E1.6    4  4.00  2.00 0.25  0.10  0.70   0.20000  1.3780  1.3520'
DataStr(164) = 'E1.6    4  4.00  2.00 0.25  0.20  1.40   0.40000  2.0552  2.3650'
DataStr(165) = 'E1.6    4  4.00  2.00 0.25  0.25  1.75   0.50000  2.7909  4.6700'
DataStr(166) = 'E1.6    4  4.00  2.00 0.25  0.10  0.50   0.15000  1.2260  1.1960'
DataStr(167) = 'E1.6    4  4.00  2.00 0.25  0.25  1.25   0.37500  1.9220  2.0990'
DataStr(168) = 'E1.6    4  4.00  2.00 0.25  0.35  1.75   0.52500  2.8680  4.9160'
DataStr(169) = 'E1.6    4  4.00  2.00 0.25  0.30  0.90   0.30000  1.6540  1.6890'
DataStr(170) = 'E1.6    4  4.00  2.00 0.25  0.50  1.50   0.50000  2.4030  3.0330'
DataStr(171) = 'E1.6    4  4.00  2.00 0.25  0.60  1.80   0.60000  3.3210  7.1475'
DataStr(172) = 'E1.6    4  4.00  2.00 0.25  0.40  0.60   0.25000  1.5055  1.4990'
DataStr(173) = 'E1.6    4  4.00  2.00 0.25  1.00  1.50   0.62500  2.8930  3.6160'
DataStr(174) = 'E1.6    4  4.00  2.00 0.25  1.20  1.80   0.75000  4.0300  8.9400'
DataStr(175) = 'E1.6    4  4.00  2.00 0.25  0.50  0.50   0.25000  1.4950  1.4950'
DataStr(176) = 'E1.6    4  4.00  2.00 0.25  1.50  1.50   0.75000  4.2570  4.2570'
DataStr(177) = 'E1.6    4  4.00  2.00 0.25  1.80  1.80   0.90000 10.4860 10.4860'
DataStr(178) = 'E1.7    4  4.00  2.00 0.50  0.05  1.00   0.26250  1.6406  1.8570'
DataStr(179) = 'E1.7    4  4.00  2.00 0.50  0.07  1.40   0.36750  2.1280  2.7950'
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DataStr(180) = 'E1.7     4  4.00   2.00 0.50  0.09   1.70   0.44625  3.0540  7.1850'
DataStr(181) = 'E1.7     4  4.00   2.00 0.50  0.10   1.00   0.27500  1.8170  1.8940'
DataStr(182) = 'E1.7     4  4.00   2.00 0.50  0.13   1.25   0.34375  2.1100  2.3540'
DataStr(183) = 'E1.7     4  4.00   2.00 0.50  0.17   1.70   0.46750  3.3040  7.5180'
DataStr(184) = 'E1.7     4  4.00   2.00 0.50  0.10   0.70   0.20000  1.5790  1.5860'
DataStr(185) = 'E1.7     4  4.00   2.00 0.50  0.20   1.40   0.40000  2.3880  2.9100'
DataStr(186) = 'E1.7     4  4.00   2.00 0.50  0.24   1.68   0.48000  3.2430  6.6350'
DataStr(187) = 'E1.7     4  4.00   2.00 0.50  0.10   0.50   0.15000  1.4340  1.4180'
DataStr(188) = 'E1.7     4  4.00   2.00 0.50  0.25   1.25   0.37500  2.2220  2.5230'
DataStr(189) = 'E1.7     4  4.00   2.00 0.50  0.34   1.70   0.51000  3.4880  8.2200'
DataStr(190) = 'E1.7     4  4.00   2.00 0.50  0.30   0.90   0.30000  1.9140  1.9610'
DataStr(191) = 'E1.7     4  4.00   2.00 0.50  0.50   1.50   0.50000  2.7790  3.9030'
DataStr(192) = 'E1.7     4  4.00   2.00 0.50  0.55   1.65   0.55000  3.3210  6.4410'
DataStr(193) = 'E1.7     4  4.00   2.00 0.50  0.40   0.60   0.25000  1.7260  1.7220'
DataStr(194) = 'E1.7     4  4.00   2.00 0.50  1.00   1.50   0.62500  3.3850  4.6550'
DataStr(195) = 'E1.7     4  4.00   2.00 0.50  1.10   1.65   0.68750  3.9590  7.8140'
DataStr(196) = 'E1.7     4  4.00   2.00 0.50  0.50   0.50   0.25000  1.7203  1.7203'
DataStr(197) = 'E1.7     4  4.00   2.00 0.50  1.50   1.50   0.75000  5.4350  5.4350'
DataStr(198) = 'E1.7     4  4.00   2.00 0.50  1.70   1.70   0.85000 13.0920 13.0920'
DataStr(199) = 'E1.8     4  4.00   2.00 1.00  0.04   0.80   0.21000  1.5210  2.2650'
DataStr(200) = 'E1.8     4  4.00   2.00 1.00  0.05   1.00   0.26250  1.7870  2.6260'
DataStr(201) = 'E1.8     4  4.00   2.00 1.00  0.07   1.40   0.36750  2.6190  5.8970'
DataStr(202) = 'E1.8     4  4.00   2.00 1.00  0.10   1.00   0.27500  2.1520  2.6680'
DataStr(203) = 'E1.8     4  4.00   2.00 1.00  0.13   1.25   0.34375  2.6020  3.8470'
DataStr(204) = 'E1.8     4  4.00   2.00 1.00  0.14   1.40   0.38500  3.0920  6.0410'
DataStr(205) = 'E1.8     4  4.00   2.00 1.00  0.10   0.70   0.20000  1.8950  2.1590'
DataStr(206) = 'E1.8     4  4.00   2.00 1.00  0.15   1.05   0.30000  2.4140  2.9080'
DataStr(207) = 'E1.8     4  4.00   2.00 1.00  0.20   1.40   0.40000  3.2660  6.2010'
DataStr(208) = 'E1.8     4  4.00   2.00 1.00  0.10   0.50   0.15000  1.7340  1.9400'
DataStr(209) = 'E1.8     4  4.00   2.00 1.00  0.20   1.00   0.30000  2.4490  2.8120'
DataStr(210) = 'E1.8     4  4.00   2.00 1.00  0.28   1.40   0.42000  3.4180  6.4090'
DataStr(211) = 'E1.8     4  4.00   2.00 1.00  0.20   0.60   0.20000  2.0740  2.1020'
DataStr(212) = 'E1.8     4  4.00   2.00 1.00  0.30   0.90   0.30000  2.4790  2.6750'
DataStr(213) = 'E1.8     4  4.00   2.00 1.00  0.47   1.41   0.47000  3.6810  7.2860'
DataStr(214) = 'E1.8     4  4.00   2.00 1.00  0.40   0.60   0.25000  2.2780  2.3000'
DataStr(215) = 'E1.8     4  4.00   2.00 1.00  0.70   1.05   0.43750  3.1390  3.5630'
DataStr(216) = 'E1.8     4  4.00   2.00 1.00  0.94   1.41   0.58750  4.4600  8.5460'
DataStr(217) = 'E1.8     4  4.00   2.00 1.00  0.50   0.50   0.25000  2.2700  2.2700'
DataStr(218) = 'E1.8     4  4.00   2.00 1.00  1.00   1.00   0.50000  3.7690  3.7690'
DataStr(219) = 'E1.8     4  4.00   2.00 1.00  1.40   1.40   0.70000  9.2600  9.2600'
DataStr(220) = 'E1.9     4  4.00   2.00 2.00  0.04   0.80   0.21000  2.2110  5.5340'
DataStr(221) = 'E1.9     4  4.00   2.00 2.00  0.05   0.90   0.23625  2.4870  7.5000'
DataStr(222) = 'E1.9     4  4.00   2.00 2.00  0.07   0.70   0.19250  2.5330  4.6700'
DataStr(223) = 'E1.9     4  4.00   2.00 2.00  0.09   0.90   0.24750  3.1780  7.5540'
DataStr(224) = 'E1.9     4  4.00   2.00 2.00  0.09   0.63   0.18000  2.6550  4.2880'
DataStr(225) = 'E1.9     4  4.00   2.00 2.00  0.12   0.84   0.24000  3.3240  6.1490'
DataStr(226) = 'E1.9     4  4.00   2.00 2.00  0.14   0.70   0.21000  3.2050  4.7400'
DataStr(227) = 'E1.9     4  4.00   2.00 2.00  0.18   0.90   0.27000  3.9840  7.7180'
DataStr(228) = 'E1.9     4  4.00   2.00 2.00  0.20   0.60   0.20000  3.4080  4.2670'
DataStr(229) = 'E1.9     4  4.00   2.00 2.00  0.30   0.90   0.30000  4.5890  8.0010'
DataStr(230) = 'E1.9     4  4.00   2.00 2.00  0.30   0.45   0.18750  3.5950  3.8450'
DataStr(231) = 'E1.9     4  4.00   2.00 2.00  0.60   0.90   0.37500  5.7190  8.8120'
DataStr(232) = 'E1.9     4  4.00   2.00 2.00  0.40   0.40   0.20000  3.8320  3.8320'
DataStr(233) = 'E1.9     4  4.00   2.00 2.00  0.90   0.90   0.45000  9.7020  9.7020'
DataStr(234) = 'E2.1     4 40.00  12.50 0.25  0.25   5.00   0.13125  2.9990  2.9700'
DataStr(235) = 'E2.1     4 40.00  12.50 0.25  0.50  10.00   0.26250  4.3500  4.2960'
DataStr(236) = 'E2.1     4 40.00  12.50 0.25  0.80  16.00   0.42000  5.8310  5.8390'
DataStr(237) = 'E2.1     4 40.00  12.50 0.25  1.10  22.00   0.57750  7.5990  8.7050'
DataStr(238) = 'E2.1     4 40.00  12.50 0.25  1.34  26.80   0.70350 11.3850 28.0300'
DataStr(239) = 'E2.1     4 40.00  12.50 0.25  0.40   4.00   0.11000  2.7360  2.7160'
DataStr(240) = 'E2.1     4 40.00  12.50 0.25  0.80   8.00   0.22000  3.9380  3.9010'
DataStr(241) = 'E2.1     4 40.00  12.50 0.25  1.20  12.00   0.33000  5.0030  4.9230'
DataStr(242) = 'E2.1     4 40.00  12.50 0.25  1.80  18.00   0.49500  6.6240  6.7500'
DataStr(243) = 'E2.1     4 40.00  12.50 0.25  2.30  23.00   0.63250  8.3540 10.1000'
DataStr(244) = 'E2.1     4 40.00  12.50 0.25  2.68  26.80   0.73700 11.7580 29.6140'
DataStr(245) = 'E2.1     4 40.00  12.50 0.25  0.50   3.50   0.10000  2.6050  2.5890'
DataStr(246) = 'E2.1     4 40.00  12.50 0.25  1.00   7.00   0.20000  3.7420  3.7060'
DataStr(247) = 'E2.1     4 40.00  12.50 0.25  2.00  14.00   0.40000  5.6950  5.5940'
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DataStr(248) = 'E2.1    4 40.00 12.50 0.25  3.00 21.00  0.60000  7.8940  8.5500'
DataStr(249) = 'E2.1    4 40.00 12.50 0.25  3.80 26.60  0.76000 11.6960 26.4510'
DataStr(250) = 'E2.1    4 40.00 12.50 0.25  0.50  2.50  0.07500  2.2550  2.2780'
DataStr(251) = 'E2.1    4 40.00 12.50 0.25  1.00  5.00  0.15000  3.2050  3.1910'
DataStr(252) = 'E2.1    4 40.00 12.50 0.25  2.50 12.50  0.37500  5.4990  5.3530'
DataStr(253) = 'E2.1    4 40.00 12.50 0.25  4.00 20.00  0.60000  8.0060  8.2170'
DataStr(254) = 'E2.1    4 40.00 12.50 0.25  5.30 26.50  0.79500 12.2050 26.0930'
DataStr(255) = 'E2.1    4 40.00 12.50 0.25  0.60  1.80  0.06000  2.0470  2.0380'
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DataStr(257) = 'E2.1    4 40.00 12.50 0.25  4.00 12.00  0.40000  5.9150  5.6220'
DataStr(258) = 'E2.1    4 40.00 12.50 0.25  6.00 18.00  0.60000  8.5370  7.8870'
DataStr(259) = 'E2.1    4 40.00 12.50 0.25  8.80 26.40  0.88000 15.5830 27.2580'
DataStr(260) = 'E2.1    4 40.00 12.50 0.25  0.80  1.20  0.05000  1.8730  1.8720'
DataStr(261) = 'E2.1    4 40.00 12.50 0.25  4.00  6.00  0.25000  4.3590  4.2505'
DataStr(262) = 'E2.1    4 40.00 12.50 0.25  6.00  9.00  0.37500  5.9610  5.5090'
DataStr(263) = 'E2.1    4 40.00 12.50 0.25  8.00 12.00  0.50000  8.2720  6.9050'
DataStr(264) = 'E2.1    4 40.00 12.50 0.25 11.50 17.25  0.71875 22.9240 10.9160'
DataStr(265) = 'E2.1    4 40.00 12.50 0.25  1.00  1.00  0.05000  1.8820  1.8800'
DataStr(266) = 'E2.1    4 40.00 12.50 0.25  5.00  5.00  0.25000  4.4250  4.2860'
DataStr(267) = 'E2.1    4 40.00 12.50 0.25  8.00  8.00  0.40000  6.8730  5.9810'
DataStr(268) = 'E2.1    4 40.00 12.50 0.25 10.00 10.00  0.50000 10.2130  7.3260'
DataStr(269) = 'E2.1    4 40.00 12.50 0.25 11.80 11.80  0.59000 22.2000 10.0040'
DataStr(270) = 'E2.2    4 40.00 12.50 2.50  0.80 16.00  0.42000  6.5510  6.4500'
DataStr(271) = 'E2.2    4 40.00 12.50 2.50  1.00 20.00  0.52500  7.7600  8.3610'
DataStr(272) = 'E2.2    4 40.00 12.50 2.50  1.20 24.00  0.63000  9.6380 14.2210'
DataStr(273) = 'E2.2    4 40.00 12.50 2.50  1.00 10.00  0.27500  5.2040  4.9300'
DataStr(274) = 'E2.2    4 40.00 12.50 2.50  2.00 20.00  0.55000  8.1200  8.6530'
DataStr(275) = 'E2.2    4 40.00 12.50 2.50  2.40 24.00  0.66000 10.0310 14.8420'
DataStr(276) = 'E2.2    4 40.00 12.50 2.50  2.00 14.00  0.40000  6.4570  6.1550'
DataStr(277) = 'E2.2    4 40.00 12.50 2.50  2.50 17.50  0.50000  7.5430  7.4640'
DataStr(278) = 'E2.2    4 40.00 12.50 2.50  3.40 23.80  0.68000 10.3380 14.6600'
DataStr(279) = 'E2.2    4 40.00 12.50 2.50  2.50 12.50  0.37500  6.2500  5.9010'
DataStr(280) = 'E2.2    4 40.00 12.50 2.50  4.00 20.00  0.60000  9.0230  9.2800'
DataStr(281) = 'E2.2    4 40.00 12.50 2.50  4.80 24.00  0.72000 11.2960 15.9900'
DataStr(282) = 'E2.2    4 40.00 12.50 2.50  4.00 12.00  0.40000  6.7290  6.2010'
DataStr(283) = 'E2.2    4 40.00 12.50 2.50  6.00 18.00  0.60000  9.8310  8.7820'
DataStr(284) = 'E2.2    4 40.00 12.50 2.50  8.00 24.00  0.80000 15.2780 17.6310'
DataStr(285) = 'E2.2    4 40.00 12.50 2.50  4.00  6.00  0.25000  5.1000  4.8100'
DataStr(286) = 'E2.2    4 40.00 12.50 2.50  8.00 12.00  0.50000 10.1360  7.7120'
DataStr(287) = 'E2.2    4 40.00 12.50 2.50 10.00 15.00  0.62500 18.5290 10.1190'
DataStr(288) = 'E2.2    4 40.00 12.50 2.50  7.00  7.00  0.35000  7.0970  6.0420'
DataStr(289) = 'E2.2    4 40.00 12.50 2.50 10.00 10.00  0.50000 14.8520  8.7840'
DataStr(290) = 'E2.3    4 40.00 12.50 5.00  0.80 16.00  0.42000  7.2280  7.2480'
DataStr(291) = 'E2.3    4 40.00 12.50 5.00  1.00 20.00  0.52500  8.6500  9.8510'
DataStr(292) = 'E2.3    4 40.00 12.50 5.00  1.20 24.00  0.63000 11.3010 22.7040'
DataStr(293) = 'E2.3    4 40.00 12.50 5.00  1.00 10.00  0.27500  5.9890  5.6140'
DataStr(294) = 'E2.3    4 40.00 12.50 5.00  2.00 20.00  0.55000  9.3920 10.1950'
DataStr(295) = 'E2.3    4 40.00 12.50 5.00  2.40 24.00  0.66000 12.1520 23.5990'
DataStr(296) = 'E2.3    4 40.00 12.50 5.00  2.00 14.00  0.40000  7.5620  6.8940'
DataStr(297) = 'E2.3    4 40.00 12.50 5.00  2.50 17.50  0.50000  8.8240  8.4560'
DataStr(298) = 'E2.3    4 40.00 12.50 5.00  3.40 23.80  0.68000 12.4520 22.1820'
DataStr(299) = 'E2.3    4 40.00 12.50 5.00  2.50 12.50  0.37500  7.3930  6.6520'
DataStr(300) = 'E2.3    4 40.00 12.50 5.00  4.00 20.00  0.60000 10.6340 10.8430'
DataStr(301) = 'E2.3    4 40.00 12.50 5.00  4.80 24.00  0.72000 13.7980 25.3890'
DataStr(302) = 'E2.3    4 40.00 12.50 5.00  4.00 12.00  0.40000  8.0490  6.9750'
DataStr(303) = 'E2.3    4 40.00 12.50 5.00  6.00 18.00  0.60000 12.1310 10.0610'
DataStr(304) = 'E2.3    4 40.00 12.50 5.00  8.00 24.00  0.80000 20.8330 27.7360'
DataStr(305) = 'E2.3    4 40.00 12.50 5.00  4.00  6.00  0.25000  6.2050  5.6280'
DataStr(306) = 'E2.3    4 40.00 12.50 5.00  8.00 12.00  0.50000 13.7680  9.0980'
DataStr(307) = 'E2.3    4 40.00 12.50 5.00  9.00 13.50  0.56250 20.5810 10.6160'
DataStr(308) = 'E2.3    4 40.00 12.50 5.00  7.00  7.00  0.35000  9.0230  7.1400'
DataStr(309) = 'E2.3    4 40.00 12.50 5.00  9.00  9.00  0.45000 16.9660  9.4220'
DataStr(310) = 'E2.4    4 40.00  5.00 2.50  1.20 24.00  0.63000 14.1420  9.4250'
DataStr(311) = 'E2.4    4 40.00  5.00 2.50  1.50 30.00  0.78750 18.0590 14.2300'
DataStr(312) = 'E2.4    4 40.00  5.00 2.50  2.00 20.00  0.55000 14.7100  8.9830'
DataStr(313) = 'E2.4    4 40.00  5.00 2.50  3.00 30.00  0.82500 31.3090 15.7090'
DataStr(314) = 'E2.4    4 40.00  5.00 2.50  2.00 14.00  0.40000 10.8900  7.4420'
DataStr(315) = 'E2.4    4 40.00  5.00 2.50  3.00 21.00  0.60000 23.0510 10.7190'
```

```
DataStr(316) = 'E2.4    4 40.00  5.00 2.50  2.00 10.00   0.30000  8.4160   6.3030'
DataStr(317) = 'E2.4    4 40.00  5.00 2.50  3.00 15.00   0.45000 16.6990   9.1220'
DataStr(318) = 'E2.4    4 40.00  5.00 2.50  2.00  6.00   0.20000  6.1500   5.0390'
DataStr(319) = 'E2.4    4 40.00  5.00 2.50  3.00  9.00   0.30000 10.8330   7.0140'
DataStr(320) = 'E2.4    4 40.00  5.00 2.50  2.00  3.00   0.12500  4.5970   4.0650'
DataStr(321) = 'E2.4    4 40.00  5.00 2.50  3.00  4.50   0.18750  7.1710   5.3290'
DataStr(322) = 'E2.4    4 40.00  5.00 2.50  2.00  2.00   0.10000  4.0960   3.7340'
DataStr(323) = 'E2.4    4 40.00  5.00 2.50  3.00  3.00   0.15000  6.0940   4.7570'
DataStr(324) = 'E2.5    4 20.00  6.25 0.25  0.20  4.00   0.21000  2.7660   2.6980'
DataStr(325) = 'E2.5    4 20.00  6.25 0.25  0.40  8.00   0.42000  4.2270   4.1430'
DataStr(326) = 'E2.5    4 20.00  6.25 0.25  0.65 13.00   0.68250  7.3040  13.0560'
DataStr(327) = 'E2.5    4 20.00  6.25 0.25  0.40  4.00   0.22000  2.8570   2.8090'
DataStr(328) = 'E2.5    4 20.00  6.25 0.25  1.00 10.00   0.55000  5.2860   5.5690'
DataStr(329) = 'E2.5    4 20.00  6.25 0.25  1.30 13.00   0.71500  7.6600  13.8410'
DataStr(330) = 'E2.5    4 20.00  6.25 0.25  0.50  3.50   0.20000  2.7060   2.6540'
DataStr(331) = 'E2.5    4 20.00  6.25 0.25  1.20  8.40   0.48000  4.7520   4.6250'
DataStr(332) = 'E2.5    4 20.00  6.25 0.25  1.80 12.60   0.72000  7.3830  11.1740'
DataStr(333) = 'E2.5    4 20.00  6.25 0.25  0.80  4.00   0.24000  2.9530   2.9610'
DataStr(334) = 'E2.5    4 20.00  6.25 0.25  2.00 10.00   0.60000  5.8800   5.9690'
DataStr(335) = 'E2.5    4 20.00  6.25 0.25  2.60 13.00   0.78000  8.4020  15.0660'
DataStr(336) = 'E2.5    4 20.00  6.25 0.25  0.80  2.40   0.16000  2.4320   2.4000'
DataStr(337) = 'E2.5    4 20.00  6.25 0.25  2.00  6.00   0.40000  4.3370   4.0380'
DataStr(338) = 'E2.5    4 20.00  6.25 0.25  3.00  9.00   0.60000  6.2580   5.6500'
DataStr(339) = 'E2.5    4 20.00  6.25 0.25  1.00  1.50   0.12500  2.0990   2.0950'
DataStr(340) = 'E2.5    4 20.00  6.25 0.25  4.00  6.00   0.50000  6.0930   4.9560'
DataStr(341) = 'E2.5    4 20.00  6.25 0.25  5.80  8.70   0.72500 19.3010   8.1230'
DataStr(342) = 'E2.5    4 20.00  6.25 0.25  1.00  1.00   0.10000  1.9160   1.8750'
DataStr(343) = 'E2.5    4 20.00  6.25 0.25  3.00  3.00   0.30000  3.6830   3.4690'
DataStr(344) = 'E2.5    4 20.00  6.25 0.25  5.80  5.80   0.58000 14.9670   6.9940'
DataStr(345) = 'E2.6    4 20.00  2.50 0.25  0.20  4.00   0.21000  3.0830   2.8500'
DataStr(346) = 'E2.6    4 20.00  2.50 0.25  0.50 10.00   0.52500  6.6210   5.2200'
DataStr(347) = 'E2.6    4 20.00  2.50 0.25  0.68 13.60   0.71400  8.8440   6.9380'
DataStr(348) = 'E2.6    4 20.00  2.50 0.25  0.40  4.00   0.22000  3.2500   3.0130'
DataStr(349) = 'E2.6    4 20.00  2.50 0.25  1.00 10.00   0.55000  7.8490   5.6370'
DataStr(350) = 'E2.6    4 20.00  2.50 0.25  1.35 13.50   0.74250 11.4530   7.4500'
DataStr(351) = 'E2.6    4 20.00  2.50 0.25  0.50  3.50   0.20000  3.0800   2.8320'
DataStr(352) = 'E2.6    4 20.00  2.50 0.25  1.20  8.40   0.48000  7.3280   5.2130'
DataStr(353) = 'E2.6    4 20.00  2.50 0.25  1.80 12.60   0.72000 15.0100   7.7060'
DataStr(354) = 'E2.6    4 20.00  2.50 0.25  0.80  4.00   0.24000  3.6560   3.2160'
DataStr(355) = 'E2.6    4 20.00  2.50 0.25  1.40  7.00   0.42000  6.8660   4.9300'
DataStr(356) = 'E2.6    4 20.00  2.50 0.25  1.80  9.00   0.54000 11.0140   6.2190'
DataStr(357) = 'E2.6    4 20.00  2.50 0.25  0.80  2.40   0.16000  2.7550   2.5160'
DataStr(358) = 'E2.6    4 20.00  2.50 0.25  1.40  4.20   0.28000  4.6700   3.7290'
DataStr(359) = 'E2.6    4 20.00  2.50 0.25  1.80  5.40   0.36000  6.9510   4.7580'
DataStr(360) = 'E2.6    4 20.00  2.50 0.25  1.00  1.50   0.12500  2.3100   2.2290'
DataStr(361) = 'E2.6    4 20.00  2.50 0.25  1.40  2.10   0.17500  3.1960   2.7480'
DataStr(362) = 'E2.6    4 20.00  2.50 0.25  1.80  2.70   0.22500  4.4290   3.3770'
DataStr(363) = 'E2.6    4 20.00  2.50 0.25  1.00  1.00   0.10000  2.1120   1.9790'
DataStr(364) = 'E2.6    4 20.00  2.50 0.25  1.40  1.40   0.14000  2.7050   2.4090'
DataStr(365) = 'E2.6    4 20.00  2.50 0.25  1.80  1.80   0.18000  3.6680   2.9820'
DataStr(366) = 'E2.7    4  8.00  2.50 0.25  0.10  2.00   0.26250  2.0490   1.9760'
DataStr(367) = 'E2.7    4  8.00  2.50 0.25  0.15  3.00   0.39375  2.6370   2.5500'
DataStr(368) = 'E2.7    4  8.00  2.50 0.25  0.25  5.00   0.65625  4.3400   6.9000'
DataStr(369) = 'E2.7    4  8.00  2.50 0.25  0.20  2.00   0.27500  2.1340   2.0620'
DataStr(370) = 'E2.7    4  8.00  2.50 0.25  0.30  3.00   0.41250  2.6990   2.6540'
DataStr(371) = 'E2.7    4  8.00  2.50 0.25  0.50  5.00   0.68750  4.4910   7.2220'
DataStr(372) = 'E2.7    4  8.00  2.50 0.25  0.30  2.10   0.30000  2.2560   2.1430'
DataStr(373) = 'E2.7    4  8.00  2.50 0.25  0.50  3.50   0.50000  3.1490   3.1530'
DataStr(374) = 'E2.7    4  8.00  2.50 0.25  0.70  4.90   0.70000  4.4630   6.6140'
DataStr(375) = 'E2.7    4  8.00  2.50 0.25  0.40  2.00   0.30000  2.2380   2.2060'
DataStr(376) = 'E2.7    4  8.00  2.50 0.25  0.80  4.00   0.60000  3.7460   3.8840'
DataStr(377) = 'E2.7    4  8.00  2.50 0.25  1.00  5.00   0.75000  5.0220   7.8390'
DataStr(378) = 'E2.7    4  8.00  2.50 0.25  0.80  2.40   0.40000  2.7910   2.6010'
DataStr(379) = 'E2.7    4  8.00  2.50 0.25  1.20  3.60   0.60000  4.0490   3.6700'
DataStr(380) = 'E2.7    4  8.00  2.50 0.25  1.60  4.80   0.80000  6.0960   6.7980'
DataStr(381) = 'E2.7    4  8.00  2.50 0.25  1.00  1.50   0.31250  2.4370   2.2400'
DataStr(382) = 'E2.7    4  8.00  2.50 0.25  1.50  2.25   0.46875  3.6640   3.0650'
DataStr(383) = 'E2.7    4  8.00  2.50 0.25  2.10  3.15   0.65625  7.9480   4.3850'
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DataStr(384) = 'E2.7    4  8.00  2.50 0.25  0.80  0.80   0.20000  1.8550  1.7790'
DataStr(385) = 'E2.7    4  8.00  2.50 0.25  1.60  1.60   0.40000  3.3450  2.8090'
DataStr(386) = 'E2.7    4  8.00  2.50 0.25  2.10  2.10   0.52500  6.3010  3.7610'
DataStr(387) = 'E2.8    4  8.00  1.00 0.25  0.10  2.00   0.26250  2.4480  2.1000'
DataStr(388) = 'E2.8    4  8.00  1.00 0.25  0.20  4.00   0.52500  4.4610  3.3740'
DataStr(389) = 'E2.8    4  8.00  1.00 0.25  0.27  5.40   0.70875  6.0280  4.5550'
DataStr(390) = 'E2.8    4  8.00  1.00 0.25  0.20  2.00   0.27500  2.6230  2.2360'
DataStr(391) = 'E2.8    4  8.00  1.00 0.25  0.45  4.50   0.61875  6.2300  4.0470'
DataStr(392) = 'E2.8    4  8.00  1.00 0.25  0.54  5.40   0.74250  8.1820  4.9660'
DataStr(393) = 'E2.8    4  8.00  1.00 0.25  0.20  1.40   0.20000  2.0970  1.8390'
DataStr(394) = 'E2.8    4  8.00  1.00 0.25  0.40  2.80   0.40000  3.9500  3.0260'
DataStr(395) = 'E2.8    4  8.00  1.00 0.25  0.70  4.90   0.70000 10.5500  4.9090'
DataStr(396) = 'E2.8    4  8.00  1.00 0.25  0.30  1.50   0.22500  2.3400  2.0230'
DataStr(397) = 'E2.8    4  8.00  1.00 0.25  0.50  2.50   0.37500  4.0260  2.9360'
DataStr(398) = 'E2.8    4  8.00  1.00 0.25  0.70  3.50   0.52500  7.6420  4.1400'
DataStr(399) = 'E2.8    4  8.00  1.00 0.25  0.30  0.90   0.15000  1.7940  1.5970'
DataStr(400) = 'E2.8    4  8.00  1.00 0.25  0.60  1.80   0.30000  3.5920  2.6160'
DataStr(401) = 'E2.8    4  8.00  1.00 0.25  0.70  2.10   0.35000  4.8600  3.0590'
DataStr(402) = 'E2.8    4  8.00  1.00 0.25  0.30  0.45   0.09375  1.4020  1.3520'
DataStr(403) = 'E2.8    4  8.00  1.00 0.25  0.50  0.75   0.15625  1.9830  1.7840'
DataStr(404) = 'E2.8    4  8.00  1.00 0.25  0.70  1.05   0.21875  3.0720  2.3180'
DataStr(405) = 'E2.8    4  8.00  1.00 0.25  0.30  0.30   0.07500  1.2640  1.2370'
DataStr(406) = 'E2.8    4  8.00  1.00 0.25  0.50  0.50   0.12500  1.7230  1.5940'
DataStr(407) = 'E2.8    4  8.00  1.00 0.25  0.70  0.70   0.17500  2.5550  2.0300'
DataStr(408) = 'E2.9    4  4.00  1.25 0.25  0.08  1.60   0.42000  2.0731  2.0280'
DataStr(409) = 'E2.9    4  4.00  1.25 0.25  0.10  2.00   0.52500  2.4530  2.6380'
DataStr(410) = 'E2.9    4  4.00  1.25 0.25  0.12  2.40   0.63000  3.0350  4.5290'
DataStr(411) = 'E2.9    4  4.00  1.25 0.25  0.10  1.00   0.27500  1.6450  1.5560'
DataStr(412) = 'E2.9    4  4.00  1.25 0.25  0.20  2.00   0.55000  2.5570  2.7400'
DataStr(413) = 'E2.9    4  4.00  1.25 0.25  0.24  2.40   0.66000  3.1720  4.7220'
DataStr(414) = 'E2.9    4  4.00  1.25 0.25  0.20  1.40   0.40000  2.0410  1.9450'
DataStr(415) = 'E2.9    4  4.00  1.25 0.25  0.25  1.75   0.50000  2.3850  2.3570'
DataStr(416) = 'E2.9    4  4.00  1.25 0.25  0.34  2.38   0.68000  3.2690  4.6460'
DataStr(417) = 'E2.9    4  4.00  1.25 0.25  0.25  1.25   0.37500  1.9760  1.8720'
DataStr(418) = 'E2.9    4  4.00  1.25 0.25  0.40  2.00   0.60000  2.8630  2.9500'
DataStr(419) = 'E2.9    4  4.00  1.25 0.25  0.48  2.40   0.72000  3.5690  5.0790'
DataStr(420) = 'E2.9    4  4.00  1.25 0.25  0.40  1.20   0.40000  2.1270  1.9890'
DataStr(421) = 'E2.9    4  4.00  1.25 0.25  0.60  1.80   0.60000  3.1210  2.7740'
DataStr(422) = 'E2.9    4  4.00  1.25 0.25  0.80  2.40   0.80000  4.8320  5.5970'
DataStr(423) = 'E2.9    4  4.00  1.25 0.25  0.40  0.60   0.25000  1.6210  1.5180'
DataStr(424) = 'E2.9    4  4.00  1.25 0.25  0.80  1.20   0.50000  3.2060  2.4360'
DataStr(425) = 'E2.9    4  4.00  1.25 0.25  1.00  1.50   0.62500  5.9080  3.2000'
DataStr(426) = 'E2.9    4  4.00  1.25 0.25  0.70  0.70   0.35000  2.2350  1.9060'
DataStr(427) = 'E2.9    4  4.00  1.25 0.25  1.00  1.00   0.50000  4.7020  2.7710'
DataStr(428) = 'E2.10   4  4.00  0.50 0.25  0.08  1.60   0.42000  2.9970  2.2550'
DataStr(429) = 'E2.10   4  4.00  0.50 0.25  0.12  2.40   0.63000  4.4720  2.9880'
DataStr(430) = 'E2.10   4  4.00  0.50 0.25  0.13  2.60   0.68250  4.8690  3.3400'
DataStr(431) = 'E2.10   4  4.00  0.50 0.25  0.10  1.00   0.27500  2.2090  1.8050'
DataStr(432) = 'E2.10   4  4.00  0.50 0.25  0.20  2.00   0.55000  4.6510  2.8620'
DataStr(433) = 'E2.10   4  4.00  0.50 0.25  0.26  2.60   0.71500  7.1440  3.7350'
DataStr(434) = 'E2.10   4  4.00  0.50 0.25  0.10  0.70   0.20000  1.7810  1.5280'
DataStr(435) = 'E2.10   4  4.00  0.50 0.25  0.20  1.40   0.40000  3.4420  2.3710'
DataStr(436) = 'E2.10   4  4.00  0.50 0.25  0.30  2.10   0.60000  7.2910  3.3970'
DataStr(437) = 'E2.10   4  4.00  0.50 0.25  0.10  0.50   0.15000  1.5080  1.3340'
DataStr(438) = 'E2.10   4  4.00  0.50 0.25  0.20  1.00   0.30000  2.6600  1.9900'
DataStr(439) = 'E2.10   4  4.00  0.50 0.25  0.30  1.50   0.45000  5.2790  2.9000'
DataStr(440) = 'E2.10   4  4.00  0.50 0.25  0.10  0.30   0.10000  1.2430  1.1370'
DataStr(441) = 'E2.10   4  4.00  0.50 0.25  0.20  0.60   0.20000  1.9430  1.5930'
DataStr(442) = 'E2.10   4  4.00  0.50 0.25  0.30  0.90   0.30000  3.4270  2.2160'
DataStr(443) = 'E2.10   4  4.00  0.50 0.25  0.10  0.15   0.06250  1.0420  0.9923'
DataStr(444) = 'E2.10   4  4.00  0.50 0.25  0.20  0.30   0.12500  1.4520  1.2830'
DataStr(445) = 'E2.10   4  4.00  0.50 0.25  0.30  0.45   0.18750  2.2670  1.6630'
DataStr(446) = 'E2.10   4  4.00  0.50 0.25  0.10  0.10   0.05000  0.9739  0.9460'
DataStr(447) = 'E2.10   4  4.00  0.50 0.25  0.20  0.20   0.10000  1.2950  1.1810'
DataStr(448) = 'E2.10   4  4.00  0.50 0.25  0.30  0.30   0.15000  1.9300  1.5000'

open(unit=7,file=ofn,status='unknown')
```

```
deleteinfile   = .true.
deleteoutfiles = .true.
honw           = 2.00d0
count          = 0
etime0         = timef()

do lun = 6,7
  write(lun,'(12a12)') &
    'h/w','d/w','r/w','c_L/r','c_R/r','FA_L','FA_R',        &
    'FA1_SC','FA2_SC','FA_L/FA1_SC','FA_R/FA2_SC','ierror'
end do

do i = 1,nDataStr
  read(DataStr(i)(6:),*) HonW,W,B,D,C1,C2,C1pC2onW,SIF1,SIF2
  r     = D/2.0d0
  clonr = C1/r
  cronr = C2/r
  donw  = B/(W/2.0d0)
  ronw  = r/(W/2.0d0)
  a     = (C1+D+C2)/2.0d0
  FA1   = SIF1/sqrt(pi*a)
  FA2   = SIF2/sqrt(pi*a)
  count = count+1
  call UCOCHFPUT(HonW,donw,ronw,clonr,cronr,fal,far,fcl,fcr,ierror, &
                 deleteinfile,deleteoutfiles)
  do lun = 6,7
    write(lun,'(11f12.6,i12)') HonW,donw,ronw,clonr,cronr,            &
                               fal,far,FA1,FA2,fal/FA1,far/FA2,ierror
  end do
end do

etime1 = timef()
etime  = etime1-etime0

do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
  write(lun,*)
end do

close(7)

end subroutine TestStressCheck

!===============================================================================

subroutine BetaECHIPS(conr,fa,fc)

! Compute Beta factors for two equal cracks emanating from a circular hole
! in an infinite plate under uniform uniaxial tension load.
!
! Input variables:
!
! conr = c/r
!
! Output variables:
!
! fa = Beta factor
! fc = Beta factor
!
! Stress intensity factors:
!
! K = S*sqrt(pi*a)*fa
!
! K = S*sqrt(pi*c)*fc
!
! S = uniform remote tension stress
```

```
! r = radius of circular hole
! c = length of left and right cracks
! a = r+c
!
! Reference:
!
! J Schijve. Stress intensity factors of hole edge cracks. Comparison
! between one crack and two symmetric cracks. International Journal
! of Fracture, Vol 23, 1983, pages R111-R115.

implicit none

real*8 conr,fa,fc

fc = 1.0d0+1.0d0/(2.0d0*conr**2+1.93d0*conr+0.539d0)+1.0d0/(2.0d0*(conr+1.0d0))
fa = fc*sqrt(conr/(1.0d0+conr))

end subroutine BetaECHIPS

!===============================================================================

real*8 function KtgOCHFWS(ronc,cone)

! Compute the value of the stress concentration factor for an offset circular
! hole in an infinite strip of finite width.
!
! Input variables:
!
! ronc = r/c
! cone = c/e
!
! r = radius of circular hole
! c = distance from hole centre to the nearest edge of strip
! e = distance from hole centre to the farthest edge of strip
!
! If c/e = 1, then the hole is located in the centre of the strip.
!
! Reference:
!
! Chart 4.3. WD Pilkey, DF Pilkey. Peterson's Stress Concentration Factors,
! Third Edition. John Wiley & Sons, Inc., 2008, ISBN: 978-0-470-04824-5.

implicit none

real*8 ronc,cone

real*8 C1,C2,C3,C4

C1 = 2.9969d0 - 0.0090d0*cone + 0.01338d0*cone**2
C2 = 0.1217d0 + 0.5180d0*cone - 0.52970d0*cone**2
C3 = 0.5565d0 + 0.7215d0*cone + 0.61530d0*cone**2
C4 = 4.0820d0 + 6.0146d0*cone - 3.98150d0*cone**2

KtgOCHFWS = C1 + C2*ronc + C3*ronc**2 + C4*ronc**3

end function KtgOCHFWS

!===============================================================================

subroutine BetaECHFWIS(conr,ronw,fa,fc)

! Compute Beta factor for two equal cracks emanating from a circular hole
! in a finite-width infinite strip under uniform uniaxial tension load.
!
! The equations used here are regarded as being accurate for:
!
! 0 <=   r/W   <= 0.70
! 0 <= c/(W-r) <= 0.95
```

```
!
! Input variables:
!
! conr = c/r
! ronw = r/W
!
! Output variables:
!
! fa = Beta factor
! fc = Beta factor
!
! Stress intensity factors:
!
! K = S*sqrt(pi*a)*fa
!
! K = S*sqrt(pi*c)*fc
!
! S = uniform remote tension stress
! r = radius of circular hole
! W = half width of infinite strip
! c = length of left and right cracks
! a = r+c
!
! References:
!
! J Schijve. Stress intensity factors of hole edge cracks. Comparison
! between one crack and two symmetric cracks. International Journal
! of Fracture, Vol 23, 1983, pages R111-R115.
!
! CE Feddersen. Discussion: Plane Strain crack toughness testing of
! high strength metallic materials (by WF Brown, Jr and JE Srawley).
! In: Plane Strain Crack Toughness Testing, ASTM STP 410, pages 77–79,
! 1966.

implicit none

real*8  conr,ronw,fa,fc

real*8  FS,s,x,conwmr,FWC,FEC,LCC

real*8, parameter:: pi = datan(1.0d0)*4.0d0

! Closed-form Beta function given by Schijve (1983), where x = c/r.

FS(x) = 1.0d0+1.0d0/(2.0d0*x**2+1.93d0*x+0.539d0)+1.0d0/(2.0d0*(x+1.0d0))

! Compute Beta factor for crack emanating from circular hole in infinite plate.

s  = conr/(1.0d0+conr)
fc = FS(conr)
fa = fc*sqrt(s)

! Geometric correction for proximity of crack tips to free edge, as proposed
! by Feddersen (1966) for a centre-cracked panel.

FEC = sqrt(1.0d0/cos(pi/2.0d0*(1.0d0+conr)*ronw))

! Geometric correction for the effect of the width of the infinite strip
! on the hole.

FWC = sqrt(1.0d0/cos(pi/2.0d0*ronw))

! Additional correction for crack length in relation to ligament length.

if (ronw == 0.0d0) then
  LCC = 1.0d0
else
  conwmr = conr/(1.0d0/ronw-1.0d0)
```

```
  LCC     = sqrt(cos(pi/2.0d0*conwmr*ronw))
end if

! Compute Beta factor using various corrections.

fc = LCC*FEC*FWC*fc
fa = LCC*FEC*FWC*fa

end subroutine BetaECHFWIS

!===============================================================================

subroutine BetaUCHFWIS(clonr,cronr,ronw,fal,far,fcl,fcr)

! WORK IN PROGRESS - UNVALIDATED (except for r/W = 0 case)
! ==========================================================
!
! Compute Beta factor for two unequal cracks emanating from a circular hole
! in a finite-width infinite strip under uniform uniaxial tension load.
!
! Input variables:
!
! clonr = cl/r
! cronr = cr/r
! ronw  = r/W
!
! Output variables:
!
! fal = Beta factor for left crack
! far = Beta factor for right crack
! fcl = Beta factor for left crack
! fcr = Beta factor for right crack
!
! Stress intensity factors:
!
! Kl = S*sqrt(pi*a)*fal
! Kr = S*sqrt(pi*a)*far
!
! Kl = S*sqrt(pi*cl)*fcl
! Kr = S*sqrt(pi*cr)*fcr
!
! r  = radius of circular hole
! W  = half width of infinite strip
! cl = length of left crack
! cr = length of right crack
! S  = uniform remote tension stress
! a  = (cl + 2*r + cr)/2

implicit none

real*8  clonr,cronr,ronw,fal,far,fcl,fcr

real*8  FS,s,x,ronwr,clonwmr,cronwmr
real*8  FWCL,FWCR,FECL,FECR,LCCL,LCCR

real*8, parameter:: pi = datan(1.0d0)*4.0d0

! Closed-form Beta function given by Schijve, where x = c/r.

FS(x) = 1.0d0+1.0d0/(2.0d0*x**2+1.93d0*x+0.539d0)+1.0d0/(2.0d0*(x+1.0d0))

! Compute Beta factor for 1st crack for a hole in an infinite plate.

s   = clonr/(1.0d0+clonr)
fcl = FS(clonr)*sqrt((1.0d0+(clonr+cronr)/2.0d0)/(1.0d0+clonr))
fal = fcl*sqrt(s)

! Compute Beta factor for 2nd crack for a hole in an infinite plate.
```

```
s   = cronr/(1.0d0+cronr)
fcr = FS(cronr)*sqrt((1.0d0+(clonr+cronr)/2.0d0)/(1.0d0+cronr))
far = fcr*sqrt(s)

! Geometric correction for 1st crack for proximity of tip to free edge.

FECL = sqrt(1.0d0/cos(pi/2.0d0*(1.0d0+clonr)*ronw))

! Geometric correction for 2nd crack for proximity of tip to free edge.

FECR = sqrt(1.0d0/cos(pi/2.0d0*(1.0d0+cronr)*ronw))

! Geometric correction for effect of width of infinite strip on hole.

FWCL = sqrt(1.0d0/cos(pi/2.0d0*ronw))
FWCR = FWCL

! Additional correction for crack length in relation to ligament length.

if (ronw == 0.0d0) then
  LCCL = 1.0d0
  LCCR = 1.0d0
else
  clonwmr = clonr/(1.0d0/ronw-1.0d0)
  LCCL    = sqrt(cos(pi/2.0d0*clonwmr*ronw))
  cronwmr = cronr/(1.0d0/ronw-1.0d0)
  LCCR    = sqrt(cos(pi/2.0d0*cronwmr*ronw))
end if

! Compute Beta factors using various corrections.

fcl = LCCL*FECL*FWCL*fcl
fcr = LCCR*FECR*FWCR*fcr

fal = LCCL*FECL*FWCL*fal
far = LCCR*FECR*FWCR*far

end subroutine BetaUCHFWIS

!===============================================================================

subroutine TestAnalyticalEqualCracksIS(ofn)

! This routine is used to analyse the Beta factors for the case of equal
! cracks growing from a circular hole in a finite-width infinite strip.

implicit none

character ofn*(*)

real*8, parameter:: pi = datan(1.0d0)*4.0d0

real*8  honw,donw,ronw,clonr,cronr,conr,conwmr
real*8  fal,far,fcl,fcr,fcavg,FA,FC
real*8  errormin,errormax
real*8  vconwmr(31)
real*8  etime0,etime1,etime
integer i,k,ierror,count,lun
logical deleteinfile,deleteoutfiles

data vconwmr/1.0d0,1.5d0,2.0d0,3.0d0,4.0d0,5.0d0,6.0d0,7.0d0,8.0d0,9.0d0, &
             1.0d1,1.5d1,2.0d1,3.0d1,4.0d1,5.0d1,6.0d1,7.0d1,8.0d1,9.0d1, &
             1.0d2,1.5d2,2.0d2,3.0d2,4.0d2,5.0d2,6.0d2,7.0d2,8.0d2,9.0d2,9.5d2/

real*8  timef

open(unit=7,file=ofn,status='unknown')
```

```
deleteinfile   = .true.
deleteoutfiles = .true.
count          = 0
etime0         = timef()

honw = 8.00d0
donw = 1.00d0

errormin = 1.0d0
errormax = 1.0d0

do lun = 6,7
  write(lun,'(9a12)') &
    'r/w','c/(w-r)','c/r','FCL_F','FCR_F','FCAVG_F','FC','FC/FCAVG_F','ierror'
end do

do k = 0,5
  select case(k)
    case(0)
      ronw = 0.00d0
    case(1)
      ronw = 0.10d0
    case(2)
      ronw = 0.25d0
    case(3)
      ronw = 0.50d0
    case(4)
      ronw = 0.60d0
    case(5)
      ronw = 0.70d0
  end select
  do i = 1,31
    if (ronw == 0.0d0) then
      conr   = vconwmr(i)*0.001d0
      conwmr = 0.0d0
    else
      conwmr = vconwmr(i)*0.001d0
      conr   = conwmr*(1.0d0/ronw-1.0d0)
    end if
    count  = count+1
    if (ronw == 0.0d0) then
      call UCCHIPUT(conr,conr,fal,far,fcl,fcr,ierror, &
                    deleteinfile,deleteoutfiles)
    else
      call UCOCHFPUT(honw,donw,ronw,conr,conr,fal,far,fcl,fcr,ierror, &
                     deleteinfile,deleteoutfiles)
    endif
    if (ierror == 0) then
      fcavg = (fcl+fcr)/2.0d0
      call BetaECHFWIS(conr,ronw,FA,FC)
      do lun = 6,7
        write(lun,'(8f12.6,i12)') &
          ronw,conwmr,conr,fcl,fcr,fcavg,FC,FC/fcavg,ierror
      end do
      if (conr >= 0.001d0) then
        errormin = min(errormin,FC/fcavg)
        errormax = max(errormax,FC/fcavg)
      end if
    end if
  end do
end do

errormin = (errormin-1.0d0)*100.0d0
errormax = (errormax-1.0d0)*100.0d0

etime1 = timef()
etime  = etime1-etime0
```

```
do lun = 6,7
  write(lun,*)
  write(lun,'(a,SP,2(f6.2,a))') &
    'Error range for cases with c/r >= 0.001: ',errormax,'%  ',errormin,'%'
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
end do

write(*,*)

close(7)

end subroutine TestAnalyticalEqualCracksIS

!===============================================================================

subroutine TestAnalyticalUnequalCracksIP(ofn)

! This routine is used to analyse the Beta factors for the case of unequal
! cracks emanatimg from a circular hole in an infinite plate.

implicit none

character ofn*(*)

real*8, parameter:: pi = datan(1.0d0)*4.0d0

real*8  L1onr,L2onr,C1onR,C2onR
real*8  F,FA1,FA2,FC1,FC2,FA1_F,FA2_F,FC1_F,FC2_F
real*8  ronw,conr(31)
real*8  etime0,etime1,etime
integer i,j,k,imax,ierror,count,lun
logical deleteinfile,deleteoutfiles

data    conr/1.0d0,1.5d0,2.0d0,3.0d0,4.0d0,5.0d0,6.0d0,7.0d0,8.0d0,9.0d0,     &
             1.0d1,1.5d1,2.0d1,3.0d1,4.0d1,5.0d1,6.0d1,7.0d1,8.0d1,9.0d1,     &
             1.0d2,1.5d2,2.0d2,3.0d2,4.0d2,5.0d2,6.0d2,7.0d2,8.0d2,9.0d2,1.0d3/

real*8  timef

open(unit=7,file=ofn,status='unknown')

deleteinfile   = .true.
deleteoutfiles = .true.
count          = 0
etime0         = timef()

do lun = 6,7
  write(lun,'(a)') 'CASE OF INFINITE PLATE (r/W = 0.0)'
  write(lun,*)
  write(lun,'(9a12)') &
    'C1/r','C2/r','FC1','FC2','FC1_F','FC2_F','FC1/FC1_F','FC2/FC2_F','ierror'
end do

ronw = 0.0d0

do i = 1,31
  do j = 1,31
    C1onr = conr(i)/100.0d0
    C2onr = conr(j)/100.0d0
    count = count+1
    call UCCHIPUT(C1onr,C2onr,FA1_F,FA2_F,FC1_F,FC2_F,ierror, &
                  deleteinfile,deleteoutfiles)
    call BetaUCHFWIS(C1onr,C2onr,ronw,FA1,FA2,FC1,FC2)
    do lun = 6,7
      write(lun,'(8f12.6,i12)') &
```

```
        C1onr,C2onr,FC1,FC2,FC1_F,FC2_F,FC1/FC1_F,FC2/FC2_F,ierror
    end do
  end do
end do

etime1 = timef()
etime  = etime1-etime0

do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
end do

write(*,*)

close(7)

end subroutine TestAnalyticalUnequalCracksIP

!===============================================================================

subroutine TestAnalyticalCracks(ofn)

! This routine is used to analyse the Beta factors for the case of unequal
! cracks growing from a circular hole in a finite-width strip.

implicit none

character ofn*(*)

real*8,  parameter:: pi = datan(1.0d0)*4.0d0
integer, parameter:: maxconr = 14

real*8   L1onr,L2onr,rpconw,C1onR,C2onR
real*8   FAF,FCF,FA1M,FA2M,FC1M,FC2M,FA1,FA2,FC1,FC2,FA,FC
real*8   F,FA1S,FA2S,FC1S,FC2S
real*8   honw,donw,ronw,clonr,cronr,fal,far,fcl,fcr,conwmr,clonwmr,cronwmr
real*8   vconwmr(20),conr(maxconr)
real*8   etime0,etime1,etime
integer  i,j,k,imax,ierror,count,lun
logical  deleteinfile,deleteoutfiles

data     conr/0.01d0,0.02d0,0.05d0,0.1d0,0.2d0,0.4d0,0.6d0,0.8d0,1.0d0, &
              1.2d0,1.4d0,1.6d0,1.8d0,2.0d0/

data     vconwmr/1.0d0,1.5d0,2.0d0,3.0d0,4.0d0,5.0d0,6.0d0,7.0d0,8.0d0,9.0d0, &
                 1.0d1,1.5d1,2.0d1,3.0d1,4.0d1,5.0d1,6.0d1,7.0d1,8.0d1,9.0d1/

real*8   timef

open(unit=7,file=ofn,status='unknown')

deleteinfile   = .true.
deleteoutfiles = .true.
count          = 0
etime0         = timef()

honw = 8.00d0
donw = 1.00d0

do lun = 6,7
  write(lun,*)
  write(lun,'(12a12)') &
    'r/w','c_L/(w-r)','c_R/(w-r)','c_L/r','c_R/r','FCL_F','FCR_F', &
    'FCL','FCR','FCL/FCL_F','FCR/FCR_F','ierror'
end do
```

```
do k = 1,5
  select case(k)
    case(1)
      ronw = 0.10d0
    case(2)
      ronw = 0.25d0
    case(3)
      ronw = 0.50d0
    case(4)
      ronw = 0.60d0
    case(5)
      ronw = 0.70d0
  end select
  do j = 1,20
    do i = 1,20
      clonwmr = vconwmr(j)*0.01d0
      cronwmr = vconwmr(i)*0.01d0
      clonr   = clonwmr*(1.0d0/ronw-1.0d0)
      cronr   = cronwmr*(1.0d0/ronw-1.0d0)
      count   = count+1
      call UCOCHFPUT(honw,donw,ronw,clonr,cronr,fal,far,fcl,fcr,ierror, &
                     deleteinfile,deleteoutfiles)
      if (ierror == 0) then
        call BetaUCHFWIS(clonr,cronr,ronw,FA1,FA2,FC1,FC2)
        do lun = 6,7
          write(lun,'(11f12.6,i12)') &
            ronw,clonwmr,cronwmr,clonr,cronr,fcl,fcr,FC1,FC2, &
            FC1/fcl,FC2/fcr,ierror
        end do
      end if
    end do
  end do
end do

etime1 = timef()
etime  = etime1-etime0

do lun = 6,7
  write(lun,*)
  write(lun,'(a,i12  )') 'Number of MFADD evaluations = ',count
  write(lun,'(a,f12.1)') 'Elapsed time in seconds     = ',etime
end do

write(*,*)

close(7)

end subroutine TestAnalyticalCracks

!=============================================================================

subroutine CreateTables(ofn)

implicit none

character ofn*(*)

integer,  parameter:: ndonw  = 10
integer,  parameter:: nronw  = 4
integer,  parameter:: nclonr = 16
integer,  parameter:: ncronr = 16
integer,  parameter:: luf    = 7

real*8    fal(ndonw,nronw,nclonr,ncronr),far(ndonw,nronw,nclonr,ncronr)
real*8    fcl,fcr
real*8    honw,faavg
real*8    ronw(nronw),donw(ndonw),clonr(nclonr),cronr(ncronr)
integer   i,j,k,l,m,ierror,lun
```

```
logical   deleteinfile,deleteoutfiles

character TableVal*12,ierrorBP*32

data donw  /0.10d0,0.20d0,0.30d0,0.40d0,0.50d0,0.60d0,0.70d0,0.80d0,0.90d0,  &
             1.00d0/
data ronw  /0.05d0,0.10d0,0.15d0,0.20d0/
data clonr /0.010d0,0.020d0,0.050d0,0.075d0,0.100d0,0.150d0,0.200d0,0.400d0, &
             0.600d0,0.800d0,1.000d0,1.200d0,1.400d0,1.600d0,1.800d0,2.000d0/
data cronr /0.010d0,0.020d0,0.050d0,0.075d0,0.100d0,0.150d0,0.200d0,0.400d0, &
             0.600d0,0.800d0,1.000d0,1.200d0,1.400d0,1.600d0,1.800d0,2.000d0/

open(unit=luf,file=ofn,status='unknown')

honw = 4.0d0

do lun = 6,7
  write(lun,'(a,i7           )') 'N:d/w=   ',ndonw
  write(lun,'(a,<ndonw>f7.3 )') 'd/w[]=   ',(donw(i),i=1,ndonw)
  write(lun,'(a,i7           )') 'N:r/w=   ',nronw
  write(lun,'(a,<nronw>f7.3 )') 'r/w[]=   ',(ronw(i),i=1,nronw)
  write(lun,'(a,i7           )') 'N:c_L/r=',nclonr
  write(lun,'(a,<nclonr>f7.3)') 'c_L/r[]=',(clonr(i),i=1,nclonr)
  write(lun,'(a,i7           )') 'N:c_R/r=',ncronr
  write(lun,'(a,<ncronr>f7.3)') 'c_R/r[]=',(cronr(i),i=1,ncronr)
  write(lun,*)
  write(lun,'(8a12)') &
    'h/w','d/w','r/w','c_L/r','c_R/r','Fa_L','Fa_R','ierror_bp'
enddo

do i = 1,ndonw
  do j = 1,nronw
    do k = 1,nclonr
      do l = 1,ncronr
        if (i==ndonw .and. j==nronw .and. k==nclonr .and. l==ncronr) then
          deleteinfile   = .true.
          deleteoutfiles = .true.
        else
          deleteinfile   = .false.
          deleteoutfiles = .false.
        end if
        call UCOCHFPUT(honw,donw(i),ronw(j),clonr(k),cronr(l),    &
                       fal(i,j,k,l),far(i,j,k,l),fcl,fcr,ierror, &
                       deleteinfile,deleteoutfiles)
        if (ierror > 0) then
          fal(i,j,k,l) = -1.0d0
          far(i,j,k,l) = -1.0d0
        endif
        if (i == ndonw .and. k == l) then
          faavg = (fal(i,j,k,l)+far(i,j,k,l))/2.0d0
          fal(i,j,k,l) = faavg
          far(i,j,k,l) = faavg
        end if
        do lun = 6,7
          if (ierror == 0) then
            write(lun,'(7f12.6,a12)')                       &
              honw,donw(i),ronw(j),clonr(k),cronr(l),     &
              fal(i,j,k,l),far(i,j,k,l),ierrorBP(ierror)
          else
            write(lun,'(5f12.6,2a12,a12)')                  &
              honw,donw(i),ronw(j),clonr(k),cronr(l),     &
              'NA','NA',ierrorBP(ierror)
          end if
        enddo
      enddo
    enddo
  enddo
enddo
```

```
write(*,*)

lun = 7

write(lun,*)
write(lun,'(a,i7           )') 'N:d/w=  ',ndonw
write(lun,'(a,<ndonw>f7.3 )') 'd/w[]=  ',(donw(i),i=1,ndonw)
write(lun,'(a,i7           )') 'N:r/w=  ',nronw
write(lun,'(a,<nronw>f7.3 )') 'r/w[]=  ',(ronw(i),i=1,nronw)
write(lun,'(a,i7           )') 'N:c_L/r=',nclonr
write(lun,'(a,<nclonr>f7.3)') 'c_L/r[]=',(clonr(i),i=1,nclonr)
write(lun,'(a,i7           )') 'N:c_R/r=',ncronr
write(lun,'(a,<ncronr>f7.3)') 'c_R/r[]=',(cronr(i),i=1,ncronr)

do i = 1,ndonw
  do j = 1,nronw
    write(lun,*)
    write(lun,'(a,f12.6)') 'h/w=',honw
    write(lun,'(a,f12.6)') 'd/w=',donw(i)
    write(lun,'(a,f12.6)') 'r/w=',ronw(j)
    write(lun,*)
    write(lun,'(a)') 'Fa_L'
    write(lun,*)
    write(lun,'(a12,<ncronr>f12.3)') 'c_L/r\c_R/r',(cronr(m),m=1,ncronr)
    do k = 1,nclonr
      write(lun,'(f6.3,a6,<ncronr>a12)') &
        clonr(k),' ',(TableVal(fal(i,j,k,m)),m=1,ncronr)
    enddo
    write(lun,*)
    write(lun,'(a)') 'Fa_R'
    write(lun,*)
    write(lun,'(a12,<ncronr>f12.3)') 'c_L/r\c_R/r',(cronr(m),m=1,ncronr)
    do k = 1,nclonr
      write(lun,'(f6.3,a6,<ncronr>a12)') &
        clonr(k),' ',(TableVal(far(i,j,k,m)),m=1,ncronr)
    enddo
  enddo
enddo

close(luf)

end subroutine CreateTables

!===============================================================================

character*12 function TableVal(a)

implicit none

real*8 a

if (a >= 0.0d0) then
  write(TableVal,'(f12.6)') a
else
  TableVal = '          NA'
end if

end function TableVal

!===============================================================================

character*32 function BitPatternI4(i)

implicit none

integer*4    i
```

```
character*32 s
integer*4    j

logical      btest

do j = 0,31
  if (btest(i,j)) then
    s(j+1:j+1) = '1'
  else
    s(j+1:j+1) = '0'
  end if
end do

BitPatternI4 = s

end function BitPatternI4

!===============================================================================

character*32 function ierrorBP(ierror)

implicit none

integer*4    ierror
character*12 strBP

character*32 BitPatternI4

if (ierror <= 0) then
  write(ierrorBP,'(i)') ierror
else
  strBP    = BitPatternI4(ierror)
  ierrorBP = '     '//strBP(1:7)
end if

end function ierrorBP

!===============================================================================

subroutine UCOCHFPUT(honw,donw,ronw,clonr,cronr,fal,far,fcl,fcr,ierror, &
                     deleteinfile,deleteoutfiles)

! This routine can be used to compute Beta factors for the general case of
! two unequal through cracks emanating from a circular hole in a 2D rectangular
! plate. A uniform uniaxial stress remote from the cracks is acting in a
! direction perpendicular to the crack line, with the stress applied to the
! top and bottom of the plate.
!
! h  = half-height of plate
! w  = half-width of plate
! r  = radius of hole
! d  = offset of the centre of the hole from the left side of the plate
! cl = length of left crack
! cr = length of right crack
!
! The MFADD boundary element program is used to perform the computations. The
! required input data file to MFADD is created from a template that is adjusted
! to suit the desired input geometry.
!
! Input variables:
!
! honw  = h/w
! donw  = d/w (= 1 if the hole is in the centre of the plate)
! ronw  = r/w
! clonr = cl/r
! cronr = cr/r
!
! deleteinfile   = .true. if the MFADD input file is to be deleted at the end
```

```
!                    of a run.
! deleteoutfiles = .true. if the set of MFADD output files is to be deleted at
!                    the end of a run.
!
! Output variables:
!
! fal     = Beta factor for left crack
! far     = Beta factor for right crack
! fcl     = Beta factor for left crack
! fcr     = Beta factor for right crack
! ierror = error code (>0 if an error condition has been encountered)
!
! The nondimensional Beta factors for the left and right cracks are obtained
! from the MFADD-computed stress intensity factors using the following equation:
!
!   fa = K/(S*sqrt(pi*a))
!
!   fc = K/(S*sqrt(pi*c))
!
! where a = (cl+2*r+cr)/2, c = cl or cr, and S is the applied uniform
! uniaxial tension stress.
!
! References:
!
! The MFADD program was provided by Professor James C Newman Jr,
! Department of Aerospace Engineering, Mississipi State University.
! It is based on an implementation of the method described in the
! following journal paper:
!
!   C Chang, ME Mear. A boundary element method for two dimensional
!   linear elastic fracture analysis. International Journal of
!   Fracture, Vol 74, pages 219-251, 1995.

implicit none

real*8    honw,clonr,cronr,donw,ronw,sifcl,sifcr,fal,far,fcl,fcr
integer   ierror
logical   deleteinfile,deleteoutfiles

real*8,  parameter:: pi = datan(1.0d0)*4.0d0
integer, parameter:: nfilestr = 137

character filestr(nfilestr)*200,linestr*200,hstr*20
integer   i,j,idum,count,int1,int2,int3
real*8    rdum
real*8    tw,th,tsigma,txhole,tyhole,trhole
real*8    xclh,xclt,xcrh,xcrt
real*8    h,d,cl,cr,xhole,yhole,rhole,a
logical   bResult

logical   systemqq
integer   len_trim,ibset,delfilesqq
real*8    datan

! Template for input data file for use with the boundary element
! program MFADD.EXE.

filestr(001) = 'FADD - Visual C++ Version 1.0 - 11/20/12'
filestr(002) = 'Two unequal cracks from a hole in a uniaxially loaded plate'
filestr(003) = ''
filestr(004) = '-----------------------------------------------------'
filestr(005) = 'Problem Type, No of Materials'
filestr(006) = '2 1'
filestr(007) = 'Materials, Elastic modulus, and Poisson''s ratio'
filestr(008) = '1 10000.000000 0.300000'
filestr(009) = 'Material, Cracks, Boundaries, and Point loads'
filestr(010) = '1 2 2 0'
filestr(011) = 'Crack-growth steps, increment, and Paris law exponent'
```

```
filestr(012) = '0 1.000000 3.000000'
filestr(013) = ' Input echo, Boundary Stresses, and Displacements'
filestr(014) = '1 1 1'
filestr(015) = ''
filestr(016) = '-------------------------------------------------------'
filestr(017) = 'Definition of Crack'
filestr(018) = ''
filestr(019) = '1 1'
filestr(020) = '1 0 0 2 1'
filestr(021) = '1 1 -10.000000 0.000000 -11.000000 0.000000 12'
filestr(022) = ''
filestr(023) = '2 1'
filestr(024) = '1 0 0 2 1'
filestr(025) = '1 1  10.000000 0.000000  11.000000 0.000000 12'
filestr(026) = ''
filestr(027) = '-------------------------------------------------------'
filestr(028) = 'Definition of Boundary'
filestr(029) = ''
filestr(030) = '1 1'
filestr(031) = '0 0 10'
filestr(032) = ''
filestr(033) = '1 1 8'
filestr(034) = '20.000000 0.000000 -1 0.000000  0 0.000000 0'
filestr(035) = '20.000000 1.000000 -1 0.000000 -1 0.000000 0'
filestr(036) = '20.000000 2.000000 -1 0.000000 -1 0.000000 0'
filestr(037) = ''
filestr(038) = '2 1 8'
filestr(039) = '20.000000  2.000000 -1 0.000000 -1 0.000000 0'
filestr(040) = '20.000000 41.000000 -1 0.000000 -1 0.000000 0'
filestr(041) = '20.000000 80.000000 -1 0.000000 -1 0.000000 0'
filestr(042) = ''
filestr(043) = '3 1 8'
filestr(044) = ' 20.000000 80.000000 -1 0.000000 -1 100.000000 0'
filestr(045) = '  0.000000 80.000000 -1 0.000000 -1 100.000000 0'
filestr(046) = '-20.000000 80.000000 -1 0.000000 -1 100.000000 0'
filestr(047) = ''
filestr(048) = '4 1 8'
filestr(049) = '-20.000000 80.000000 -1 0.000000 -1 0.000000 0'
filestr(050) = '-20.000000 41.000000 -1 0.000000 -1 0.000000 0'
filestr(051) = '-20.000000  2.000000 -1 0.000000 -1 0.000000 0'
filestr(052) = ''
filestr(053) = '5 1 8'
filestr(054) = '-20.000000 2.000000 -1 0.000000 -1 0.000000 0'
filestr(055) = '-20.000000 1.000000 -1 0.000000 -1 0.000000 0'
filestr(056) = '-20.000000 0.000000  0 0.000000  0 0.000000 0'
filestr(057) = ''
filestr(058) = '6 1 8'
filestr(059) = '-20.000000  0.000000  0 0.000000  0 0.000000 0'
filestr(060) = '-20.000000 -1.000000 -1 0.000000 -1 0.000000 0'
filestr(061) = '-20.000000 -2.000000 -1 0.000000 -1 0.000000 0'
filestr(062) = ''
filestr(063) = '7 1 8'
filestr(064) = '-20.000000  -2.000000 -1 0.000000 -1 0.000000 0'
filestr(065) = '-20.000000 -41.000000 -1 0.000000 -1 0.000000 0'
filestr(066) = '-20.000000 -80.000000 -1 0.000000 -1 0.000000 0'
filestr(067) = ''
filestr(068) = '8 1 8'
filestr(069) = '-20.000000 -80.000000 -1 0.000000 -1 -100.000000 0'
filestr(070) = '  0.000000 -80.000000 -1 0.000000 -1 -100.000000 0'
filestr(071) = ' 20.000000 -80.000000 -1 0.000000 -1 -100.000000 0'
filestr(072) = ''
filestr(073) = '9 1 8'
filestr(074) = '20.000000 -80.000000 -1 0.000000 -1 0.000000 0'
filestr(075) = '20.000000 -41.000000 -1 0.000000 -1 0.000000 0'
filestr(076) = '20.000000  -2.000000 -1 0.000000 -1 0.000000 0'
filestr(077) = ''
filestr(078) = '10 1 8'
filestr(079) = '20.000000 -2.000000 -1 0.000000 -1 0.000000 0'
```

```
filestr(080) = '20.000000 -1.000000 -1 0.000000 -1 0.000000 0'
filestr(081) = '20.000000  0.000000 -1 0.000000  0 0.000000 0'
filestr(082) = ''
filestr(083) = '2 1'
filestr(084) = '2 0 10'
filestr(085) = ''
filestr(086) = '1 0 0.000000 0.000000 10.000000 12'
filestr(087) = '180.000000 -1 0.000000 -1 0.000000 1'
filestr(088) = '175.000000 -1 0.000000 -1 0.000000 0'
filestr(089) = '170.000000 -1 0.000000 -1 0.000000 0'
filestr(090) = ''
filestr(091) = '2 0 0.000000 0.000000 10.000000 4'
filestr(092) = '170.000000 -1 0.000000 -1 0.000000 0'
filestr(093) = '152.500000 -1 0.000000 -1 0.000000 0'
filestr(094) = '135.000000 -1 0.000000 -1 0.000000 0'
filestr(095) = ''
filestr(096) = '3 0 0.000000 0.000000 10.000000 4'
filestr(097) = '135.000000 -1 0.000000 -1 0.000000 0'
filestr(098) = ' 90.000000 -1 0.000000 -1 0.000000 0'
filestr(099) = ' 45.000000 -1 0.000000 -1 0.000000 0'
filestr(100) = ''
filestr(101) = '4 0 0.000000 0.000000 10.000000 4'
filestr(102) = '45.000000 -1 0.000000 -1 0.000000 0'
filestr(103) = '27.500000 -1 0.000000 -1 0.000000 0'
filestr(104) = '10.000000 -1 0.000000 -1 0.000000 0'
filestr(105) = ''
filestr(106) = '5 0 0.000000 0.000000 10.000000 12'
filestr(107) = '10.000000 -1 0.000000 -1 0.000000 0'
filestr(108) = ' 5.000000 -1 0.000000 -1 0.000000 0'
filestr(109) = ' 0.000000 -1 0.000000 -1 0.000000 2'
filestr(110) = ''
filestr(111) = '6 0 0.000000 0.000000 10.000000 12'
filestr(112) = '  0.000000 -1 0.000000 -1 0.000000 2'
filestr(113) = ' -5.000000 -1 0.000000 -1 0.000000 0'
filestr(114) = '-10.000000 -1 0.000000 -1 0.000000 0'
filestr(115) = ''
filestr(116) = '7 0 0.000000 0.000000 10.000000 4'
filestr(117) = '-10.000000 -1 0.000000 -1 0.000000 0'
filestr(118) = '-27.500000 -1 0.000000 -1 0.000000 0'
filestr(119) = '-45.000000 -1 0.000000 -1 0.000000 0'
filestr(120) = ''
filestr(121) = '8 0 0.000000 0.000000 10.000000 4'
filestr(122) = ' -45.000000 -1 0.000000 -1 0.000000 0'
filestr(123) = ' -90.000000 -1 0.000000 -1 0.000000 0'
filestr(124) = '-135.000000 -1 0.000000 -1 0.000000 0'
filestr(125) = ''
filestr(126) = '9 0 0.000000 0.000000 10.000000 4'
filestr(127) = '-135.000000 -1 0.000000 -1 0.000000 0'
filestr(128) = '-152.500000 -1 0.000000 -1 0.000000 0'
filestr(129) = '-170.000000 -1 0.000000 -1 0.000000 0'
filestr(130) = ''
filestr(131) = '10 0 0.000000 0.000000 10.000000 12'
filestr(132) = '-170.000000 -1 0.000000 -1 0.000000 0'
filestr(133) = '-175.000000 -1 0.000000 -1 0.000000 0'
filestr(134) = '-180.000000 -1 0.000000 -1 0.000000 1'
filestr(135) = ''
filestr(136) = '-------------------------------------------------------'
filestr(137) = ''

! Read plate and hole dimensions from datafile template.

read(filestr(044),*) tw,th,idum,rdum,idum,tsigma
read(filestr(086),*) idum,idum,txhole,tyhole,trhole

! Modify the datafile template.

d     = donw*tw
rhole = ronw*tw
```

```
xhole = -tw+d
yhole = 0.0d0
cl    = clonr*rhole
cr    = cronr*rhole
xclh  = xhole-rhole
xclt  = xclh-cl
xcrh  = xhole+rhole
xcrt  = xcrh+cr
a     = (cl+cr+2.0d0*rhole)/2.0d0
h     = honw*tw

! Check crack definition, hole dimensions and location in order
! to ensure that the geometry is feasible. Set an error flag to
! indicate what type of error has occurred.

ierror = 0
fcl    = 0.0d0
fcr    = 0.0d0

if (clonr        <= 0.00d0) ierror = ibset(ierror,0)
if (cronr        <= 0.00d0) ierror = ibset(ierror,1)
if (xhole-rhole  <=    -tw) ierror = ibset(ierror,2)
if (xhole+rhole  >=     tw) ierror = ibset(ierror,3)
if (xclt         <=    -tw) ierror = ibset(ierror,4)
if (xcrt         >=     tw) ierror = ibset(ierror,5)
if (abs(xclt/tw) >= 0.99d0) ierror = ibset(ierror,6)
if (abs(xcrt/tw) >= 0.99d0) ierror = ibset(ierror,7)

if (ierror > 0) return

! Adjust height of plate to produce desired H/W ratio.

write(hstr,'(f20.6)') h
hstr = adjustl(hstr)

do i = 34,81
  j = index(filestr(i),'80.000000')
  if (j > 0) then
    filestr(i) = filestr(i)(1:j-1)//trim(hstr)//filestr(i)(j+9:)
  end if
end do

write(hstr,'(f20.6)') (h+2.0d0)/2.0d0
hstr = adjustl(hstr)

i = 40
j = index(filestr(i),'41.000000')
filestr(i) = filestr(i)(1:j-1)//trim(hstr)//filestr(i)(j+9:)
i = 50
j = index(filestr(i),'41.000000')
filestr(i) = filestr(i)(1:j-1)//trim(hstr)//filestr(i)(j+9:)
i = 65
j = index(filestr(i),'41.000000')
filestr(i) = filestr(i)(1:j-1)//trim(hstr)//filestr(i)(j+9:)
i = 75
j = index(filestr(i),'41.000000')
filestr(i) = filestr(i)(1:j-1)//trim(hstr)//filestr(i)(j+9:)

! Adjust hole radius and location of centre.

do i = 1,10
  j = (i-1)*5+86
  read(filestr(j),*) int1,int2,rdum,rdum,rdum,int3
  write(filestr(j),'(i2,i2,3f20.6,i6)') int1,int2,xhole,yhole,rhole,int3
end do

! Adjust definitions of the two assumed cracks.
```

```
read(filestr(021),*) int1,int2,rdum,rdum,rdum,rdum,int3
write(filestr(021),'(i1,i2,4f15.6,i3)') int1,int2,xclh,0.0d0,xclt,0.0d0,int3
read(filestr(025),*) int1,int2,rdum,rdum,rdum,rdum,int3
write(filestr(025),'(i1,i2,4f15.6,i3)') int1,int2,xcrh,0.0d0,xcrt,0.0d0,int3

! Write the datafile for use by MFADD.EXE.

open(unit=1,file='fadd.in',status='replace')
do i = 1,nfilestr
  write(1,'(a)') filestr(i)(1:len_trim(filestr(i)))
end do
close(1)

! Run MFADD to compute the SIFs.

bResult = systemqq('MFADD.EXE')

! Read in the computed SIFs.

open(unit=1,file='sifs.ot',status='old')
read(1,'(a)') linestr
i = index(linestr,'xxx',back=.true.)+3
linestr = linestr(i:)
read(linestr,*) sifcl
read(1,'(a)') linestr
i = index(linestr,'xxx',back=.true.)+3
linestr = linestr(i:)
read(linestr,*) sifcr
close(1)

! Normalise the computed SIFs to unit stress.

sifcl = sifcl/tsigma
sifcr = sifcr/tsigma

! Calculate the Beta factors for the left and right cracks.

fal = sifcl/sqrt(pi*a)
far = sifcr/sqrt(pi*a)

fcl = sifcl/sqrt(pi*cl)
fcr = sifcr/sqrt(pi*cr)

! If desired, delete the MFADD input file that has been written out,
! and also delete the various output files generated by MFADD.

if (deleteinfile) then
  count = delfilesqq('fadd.in')
end if

if (deleteoutfiles) then
  count = delfilesqq('sifs.ot')
  count = delfilesqq('fadd.ot')
  count = delfilesqq('mesh.ot')
  count = delfilesqq('ncrk.ot')
  count = delfilesqq('errs.ot')
  count = delfilesqq('disp.ot')
  count = delfilesqq('trac.ot')
end if

end subroutine UCOCHFPUT

!===============================================================================

subroutine UCCHIPUT(clonr,cronr,fal,far,fcl,fcr,ierror, &
                    deleteinfile,deleteoutfiles)

! This routine can be used to compute Beta factors for the general case of
```

```
! two unequal through cracks emanating from a circular hole in a 2D infinite
! plate. A uniform uniaxial stress remote from the cracks is acting in a
! direction perpendicular to the crack line, with the stress applied to the
! top and bottom of the plate.
!
! The MFADD boundary element program is used to perform the computations. The
! required input data file to MFADD is created from a template that is adjusted
! to suit the desired input geometry.
!
! Input variables:
!
! clonr = cl/r
! cronr = cr/r
!
! deleteinfile   = .true. if the MFADD input file is to be deleted at the end
!                  of a run.
! deleteoutfiles = .true. if the set of MFADD output files is to be deleted at
!                  the end of a run.
!
! Output variables:
!
! fal    = Beta factor for left crack
! far    = Beta factor for right crack
! fcl    = Beta factor for left crack
! fcr    = Beta factor for right crack
! ierror = error code (>0 if an error condition has been encountered)
!
! The nondimensional Beta factors for the left and right cracks are
! obtained from the MFADD-computed stress intensity factors using the
! following equations:
!
!   fa = K/(S*sqrt(pi*a))
!
!   fc = K/(S*sqrt(pi*c))
!
! where a = (cl + 2*r + cr)/2, c = cl or cr, and S is the applied
! tension stress.
!
! References:
!
! The MFADD program was kindly provided by James C Newman Jr, Department
! of Aerospace Engineering, Mississipi State University. It is based on
! an implementation of the method described in the following journal
! paper:
!
!   C Chang, ME Mear. A boundary element method for two dimensional
!   linear elastic fracture analysis. International Journal of
!   Fracture, Vol 74, pages 219-251, 1995.

implicit none

real*8    clonr,cronr,sifcl,sifcr,fal,far,fcl,fcr
integer   ierror
logical   deleteinfile,deleteoutfiles

real*8, parameter:: pi = datan(1.0d0)*4.0d0

character filestr(100)*200,linestr*200
integer   nfilestr,i,idum,count
real*8    xclh,xclt,xcrh,xcrt
real*8    sigma,cl,cr,xhole,yhole,rhole,a,rdum
logical   bResult

logical   systemqq
integer   len_trim,ibset,delfilesqq
real*8    datan

! Template for input data file for use with the boundary element
```

```
! program MFADD.EXE.

filestr(01) = 'FADD - Visual C++ Version 1.0 - 08/13/12'
filestr(02) = 'Two cracks from hole in infinite plate under uniform stress'
filestr(03) = ''
filestr(04) = '-------------------------------------------------------'
filestr(05) = 'Problem Type, No of Materials'
filestr(06) = '3 1'
filestr(07) = 'Material, SigXX, SigYY, SigXY, Zx, Zy,'
filestr(08) = '1 0.000000 100.000000 0.000000 0.000000 0.000000'
filestr(09) = 'Materials, Elastic modulus, and Poisson''s ratio'
filestr(10) = '1 10000.000000 0.300000'
filestr(11) = 'Material, Cracks, Boundaries, and Point loads'
filestr(12) = '1 2 1 0'
filestr(13) = 'Crack-growth steps, increment, and Paris law exponent'
filestr(14) = '0 0.250000 3.000000'
filestr(15) = 'Input echo, Boundary Stresses, and Displacements'
filestr(16) = '1 1 1'
filestr(17) = ''
filestr(18) = '-------------------------------------------------------'
filestr(19) = 'Definition of Crack'
filestr(20) = ''
filestr(21) = '1 1'
filestr(22) = '1 0 0 2 1'
filestr(23) = '1 1 -10.000000 0.000000 -11.000000 0.000000 22'
filestr(24) = ''
filestr(25) = '2 1'
filestr(26) = '1 0 0 2 1'
filestr(27) = '1 1  10.000000 0.000000  11.000000 0.000000 22'
filestr(28) = ''
filestr(29) = '-------------------------------------------------------'
filestr(30) = 'Definition of Boundary'
filestr(31) = ''
filestr(32) = '1 1'
filestr(33) = '2 0 10'
filestr(34) = ''
filestr(35) = '1 0 0.000000 0.000000 10.000000 16'
filestr(36) = '180.000000 -1 0.000000 -1 0.000000 1'
filestr(37) = '175.000000 -1 0.000000 -1 0.000000 0'
filestr(38) = '170.000000 -1 0.000000 -1 0.000000 0'
filestr(39) = ''
filestr(40) = '2 0 0.000000 0.000000 10.000000 4'
filestr(41) = '170.000000 -1 0.000000 -1 0.000000 0'
filestr(42) = '152.500000 -1 0.000000 -1 0.000000 0'
filestr(43) = '135.000000 -1 0.000000 -1 0.000000 0'
filestr(44) = ''
filestr(45) = '3 0 0.000000 0.000000 10.000000 6'
filestr(46) = '135.000000 -1 0.000000 -1 0.000000 0'
filestr(47) = ' 90.000000 -1 0.000000 -1 0.000000 0'
filestr(48) = ' 45.000000 -1 0.000000 -1 0.000000 0'
filestr(49) = ''
filestr(50) = '4 0 0.000000 0.000000 10.000000 4'
filestr(51) = '45.000000 -1 0.000000 -1 0.000000 0'
filestr(52) = '27.500000 -1 0.000000 -1 0.000000 0'
filestr(53) = '10.000000 -1 0.000000 -1 0.000000 0'
filestr(54) = ''
filestr(55) = '5 0 0.000000 0.000000 10.000000 16'
filestr(56) = '10.000000 -1 0.000000 -1 0.000000 0'
filestr(57) = ' 5.000000 -1 0.000000 -1 0.000000 0'
filestr(58) = ' 0.000000 -1 0.000000 -1 0.000000 2'
filestr(59) = ''
filestr(60) = '6 0 0.000000 0.000000 10.000000 16'
filestr(61) = '  0.000000 -1 0.000000 -1 0.000000 2'
filestr(62) = ' -5.000000 -1 0.000000 -1 0.000000 0'
filestr(63) = '-10.000000 -1 0.000000 -1 0.000000 0'
filestr(64) = ''
filestr(65) = '7 0 0.000000 0.000000 10.000000 4'
filestr(66) = '-10.000000 -1 0.000000 -1 0.000000 0'
```

```
filestr(67) = '-27.500000 -1 0.000000 -1 0.000000 0'
filestr(68) = '-45.000000 -1 0.000000 -1 0.000000 0'
filestr(69) = ''
filestr(70) = '8 0 0.000000 0.000000 10.000000 6'
filestr(71) = ' -45.000000 -1 0.000000 -1 0.000000 0'
filestr(72) = ' -90.000000 -1 0.000000 -1 0.000000 0'
filestr(73) = '-135.000000 -1 0.000000 -1 0.000000 0'
filestr(74) = ''
filestr(75) = '9 0 0.000000 0.000000 10.000000 4'
filestr(76) = '-135.000000 -1 0.000000 -1 0.000000 0'
filestr(77) = '-152.500000 -1 0.000000 -1 0.000000 0'
filestr(78) = '-170.000000 -1 0.000000 -1 0.000000 0'
filestr(79) = ''
filestr(80) = '10 0 0.000000 0.000000 10.000000 16'
filestr(81) = '-170.000000 -1 0.000000 -1 0.000000 0'
filestr(82) = '-175.000000 -1 0.000000 -1 0.000000 0'
filestr(83) = '-180.000000 -1 0.000000 -1 0.000000 1'
filestr(84) = ''
filestr(85) = '-------------------------------------------------------'

nfilestr = 85

! Read hole dimensions from datafile template.

read(filestr(35),*) idum,idum,xhole,yhole,rhole

! Read remote stress from datafile template.

read(filestr(08),*) idum,rdum,sigma

! Modify the datafile template.

cl    = clonr*rhole
cr    = cronr*rhole
xclh  = xhole-rhole
xclt  = xclh-cl
xcrh  = xhole+rhole
xcrt  = xcrh+cr
a     = (cl+cr+2.0d0*rhole)/2.0d0

! Check crack definition, hole dimensions and location in order
! to ensure that the geometry is feasible. Set an error flag to
! indicate what type of error has occurred.

ierror = 0
fcl    = 0.0d0
fcr    = 0.0d0

if (clonr <= 0.0d0) ierror = ibset(ierror,0)
if (cronr <= 0.0d0) ierror = ibset(ierror,1)

if (ierror > 0) return

! Adjust definitions of the two assumed cracks.

write(filestr(23),'(i1,i2,4f15.6,i3)') 1,1,xclh,0.0d0,xclt,0.0d0,22
write(filestr(27),'(i1,i2,4f15.6,i3)') 1,1,xcrh,0.0d0,xcrt,0.0d0,22

! Write the datafile for use by MFADD.EXE.

open(unit=1,file='fadd.in',status='replace')
do i = 1,nfilestr
  write(1,'(a)') filestr(i)(1:len_trim(filestr(i)))
end do
close(1)

! Run MFADD to compute the SIFs.
```

```
bResult = systemqq('MFADD.EXE')

! Read in the computed SIFs.

open(unit=1,file='sifs.ot',status='old')
read(1,'(a)') linestr
i = index(linestr,'xxx',back=.true.)+3
linestr = linestr(i:)
read(linestr,*) sifcl
read(1,'(a)') linestr
i = index(linestr,'xxx',back=.true.)+3
linestr = linestr(i:)
read(linestr,*) sifcr
close(1)

! Normalise the computed SIFs to unit stress.

sifcl = sifcl/sigma
sifcr = sifcr/sigma

! Calculate the Beta factors for the left and right cracks.

fal = sifcl/sqrt(pi*a)
far = sifcr/sqrt(pi*a)

fcl = sifcl/sqrt(pi*cl)
fcr = sifcr/sqrt(pi*cr)

! If desired, delete the MFADD input file that has been written out,
! and also delete the various output files generated by MFADD.

if (deleteinfile) then
  count = delfilesqq('fadd.in')
end if

if (deleteoutfiles) then
  count = delfilesqq('sifs.ot')
  count = delfilesqq('fadd.ot')
  count = delfilesqq('mesh.ot')
  count = delfilesqq('ncrk.ot')
  count = delfilesqq('errs.ot')
  count = delfilesqq('disp.ot')
  count = delfilesqq('trac.ot')
end if

end subroutine UCCHIPUT
```

Appendix D: Screen display of menu choices for RunMFADD program and names of output files

```
==================================================================
    Solution of crack problems using FADD2D boundary element code
==================================================================

 1 Compute solutions to Rooke and Tweed test cases
 2 Compute solutions to Nisitani and Isida test cases
 3 Compute solutions to Isida and Nakamura test cases
 4 Compute solutions to Murakami test cases
 5 Compute closed-form equal-crack infinite plate solutions
 6 Compute closed-form equal-crack infinite strip solutions
 7 Compute closed-form unequal-crack infinite plate solutions
 8 Compute solutions to some other test cases
 9 Compute solutions to StressCheck offset hole test cases
10 Compute solutions for asymmetric cracks with plate width effects
11 Compute solutions for varying hole offsets and crack lengths

 0 Exit

Input choice: _
```

Output files associated with different options chosen from menu.

Menu Choice	Name of Output File
1	PlateTestRookeTweed.out
2	PlateTestNisitaniIsida.out
3	PlateTestIsidaNakamura.out
4	PlateTestMurakami.out
5	PlateTestAnalyticalEqualCracksIP.out
6	PlateTestAnalyticalEqualCracksIS.out
7	PlateTestAnalyticalUnequalCracksIP.out
8	PlateTestOtherCases.out
9	PlateTestStressCheck.out
10	PlateTestAnalyticalCracks.out
11	PlateTables.out

Appendix E: Excerpt from computed tabulated results together with table header

```
N:d/w=       10
d/w[]=     0.100  0.200  0.300  0.400  0.500  0.600  0.700  0.800 ...
N:r/w=        4
r/w[]=     0.050  0.100  0.150  0.200
N:c_L/r=     16
c_L/r[]=   0.010  0.020  0.050  0.075  0.100  0.150  0.200  0.400 ...
N:c_R/r=     16
c_R/r[]=   0.010  0.020  0.050  0.075  0.100  0.150  0.200  0.400 ...

h/w=     4.000000
d/w=     0.100000
r/w=     0.050000

Fa_L

 c_L/r\c_R/r        0.010        0.020        0.050        0.075       ...
 0.010           0.365734     0.351840     0.351071     0.350499       ...
 0.020           0.496586     0.478402     0.476905     0.476665       ...
 0.050           0.756853     0.731328     0.728997     0.728223       ...
 0.075           0.882752     0.854410     0.851510     0.850549       ...
 0.100           0.968404     0.939180     0.935871     0.934664       ...
 0.150           1.095859     1.065731     1.061974     1.060702       ...
 0.200           1.172371     1.142686     1.138730     1.137019       ...
 0.400           1.318833     1.291391     1.287172     1.285420       ...
 0.600           1.415008     1.391508     1.387411     1.385353       ...
 0.800                 NA           NA           NA           NA       ...
 1.000                 NA           NA           NA           NA       ...
 1.200                 NA           NA           NA           NA       ...
 1.400                 NA           NA           NA           NA       ...
 1.600                 NA           NA           NA           NA       ...
 1.800                 NA           NA           NA           NA       ...
 2.000                 NA           NA           NA           NA       ...

Fa_R

 c_L/r\c_R/r        0.010        0.020        0.050        0.075       ...
 0.010           0.341363     0.478865     0.712446     0.827774       ...
 0.020           0.339862     0.476682     0.709236     0.824177       ...
 0.050           0.338564     0.474880     0.706714     0.821214       ...
 0.075           0.337442     0.473333     0.704485     0.818721       ...
 0.100           0.336525     0.471929     0.702469     0.816418       ...
 0.150           0.335674     0.470716     0.700801     0.814687       ...
 0.200           0.335322     0.470130     0.700082     0.813985       ...
 0.400           0.338055     0.473603     0.705881     0.821455       ...
 0.600           0.344732     0.482572     0.720148     0.838686       ...
 0.800                 NA           NA           NA           NA       ...
 1.000                 NA           NA           NA           NA       ...
 1.200                 NA           NA           NA           NA       ...
 1.400                 NA           NA           NA           NA       ...
 1.600                 NA           NA           NA           NA       ...
 1.800                 NA           NA           NA           NA       ...
 2.000                 NA           NA           NA           NA       ...
```

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Witold Waldman

5. CORPORATE AUTHOR

Defence Science and Technology Group
506 Lorimer St
Fishermans Bend Victoria 3207 Australia

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Beta factor, Stress intensity factor, Holes, Aircraft structure, Stress concentration, Fatigue life extension, Boundary element analysis, Numerical modelling, Numerical simulation, Cracks

19. ABSTRACT

Beta factors, a nondimensional form of stress intensity factor, are a key input used in generating crack-growth curves as part of Damage Tolerance Analysis work. One specific damage scenario that is of interest is the case of collinear asymmetrical cracks emanating from an offset circular hole in a finite-width rectangular plate, which is representative of circumstances that can occur in aircraft fleets. Unfortunately, no handbook results are available for this geometry. Using a custom-written FORTRAN computer program, interfaced with an existing two-dimensional boundary element fracture analysis code, the present report provides an extensive set of Beta factor solutions covering a wide range of hole offsets and crack lengths. This work has also led to the derivation of an improved closed-form analytical two-dimensional Beta factor solution for the related case of symmetrical cracks emanating from a central hole in a finite-width strip. The availability of accurate Beta factors is an important element in the structural integrity management of aircraft in service with the Royal Australian Air Force. The database of results presented here supports research into probabilistic analysis of multi-site fatigue damage scenarios, as well as assisting the long-term ongoing structural integrity management of aircraft in service with the Royal Australian Air Force.